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Circular Construction:

A Study of Reuse Practices in the Construction Industry from a Consultant´s Perspective

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Master of Science Thesis

Title	Circular Construction – A Study of Reuse Practices and Perspectives in the Construction Industry
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Abstract

In light of the need to reduce resource usage and mitigate the climate impact of the Swedish construction industry, the adoption of reusing secondary materials has gained significant attention as an alternative construction process. This approach not only addresses environmental concerns, but also aims to transition from the prevailing "make-take-waste" system of resource management. Reuse, recognized as a circular method, holds promise for the construction industry's efforts to reduce the embodied environmental impact from construction. However, the identification of key actors responsible for spearheading the implementation of reuse to make it both economically and environmentally beneficial remains vague, creating an opportunity for consultancy firms to offer their expertise and knowledge in this domain.

This thesis explores the opportunities and challenges related to the implementation of reuse in the construction industry to formulate possibilities for consultants to introduce reuse in projects. This is done from the context of a Swedish consultancy company by using qualitative methods including a literature review and semi-structured interviews, to investigate different views and experiences of implementing reuse among a variety of actors in the construction process. Based on the results, analysis and discussion, it can be concluded that the project dependent nature of implementing reuse creates a division between the more optimistic views, who see benefits with initiating reuse in most projects, and the more restrained views, which raises the concern of how the benefits of reuse can be misinterpreted. There are two identified challenges that need to be met in order to make the benefits evident for all actors; to enhance the market for reuse in the industry through economic incentives and company driven initiatives, and to change the industry's mindset by prioritising repurposing of buildings and putting weight on coordination in the early stages of construction projects. Consultants can have a supporting role in the early stages of projects by coordinating the logistics and management of secondary materials, and consequently ease the pressure for other actors in the value chain. It is additionally shown that even if there is a wide range of expertise within the consultancy company, it can be hard to manage in order to maximise the benefits of reuse in projects.

Masterexamensarbete

Titel	Cirkulär konstruktion – En studie av perspektiv på och tillämpning av återbruk i byggbranschen
Författare	Jacob Foconi & Johan Åberg
Avdelning	Avdelningen för urbana och regionala studier
Handledare	Hanna Eggestrand Vaughan
Nyckelord	Återbruk, Cirkulär Ekonomi, Byggbranschen, Resursanvändning, Inbäddad Miljöpåverkan

Sammanfattning

Som en följd av behovet av att minska resursanvändningen och klimatpåverkan från den svenska byggbranschen, har återbruk av sekundära byggmaterial fått stor uppmärksamhet som en alternativ byggprocess. Detta tillvägagångssätt tar inte bara hänsyn till miljöfrågor, utan syftar även till att övergå från det nuvarande systemet för resurshantering enligt "make-take-waste"- principen till ett cirkulärt system. Återbruk anses på så sätt vara en cirkulär metod som har potential till att minska byggnadens inbäddade miljöpåverkan. Det är emellertid fortfarande inte klarlagt vilka nyckelaktörer som ska leda implementeringen av återbruk i byggprojekt så att det förblir både ekonomiskt och miljömässigt gynnsamt. Detta skapar en möjlighet för konsultföretag att erbjuda sin expertis och sina kunskaper inom detta område.

I denna uppsats undersöks de möjligheter och utmaningar som är kopplade till implementeringen av återbruk i byggbranschen, för att kunna formulera möjligheter för konsulter att införa återbruk i projekt. Detta görs utifrån kontexten av ett svenskt konsultföretag genom att använda kvalitativa metoder, innefattande litteraturstudier och semistrukturerade intervjuer, för att undersöka synsätt och erfarenheter av att implementera återbruk bland olika aktörer i byggprocessen. Baserat på resultat, analys och diskussion går det att dra slutsatsen att den projektbaserade processen för att implementera återbruk skapar en uppdelning mellan de mer optimistiska åsikterna, som ser fördelar med att initiera återbruk i de flesta av sina projekt, och de mer återhållsamma åsikterna, vilka väcker oro för hur återbrukets fördelar kan feltolkas av aktörer. Det finns två huvudsakliga utmaningar som måste bemötas för att fördelarna ska bli uppenbara för alla aktörer: att stärka marknaden för återbruk inom industrin genom ekonomiska incitament och företagsdrivna initiativ, och att ändra industrins tankesätt genom att prioritera vidareutnyttjande av byggnader och lägga vikt vid samordning i de tidiga skedena av byggprojekt. Konsulter kan spela en viktig roll i byggprojektets tidiga skeden genom att samordna logistiken och hanteringen av sekundära byggmaterial, och därmed minska belastningen för andra aktörer i värdekedjan. Dessutom framgår det att även om det finns en bred kompetens inom konsultföretaget, kan det vara svårt att förvalta denna för att maximera fördelarna med återbruk i projekten.

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Table of Contents

1. Introduction

The rate of consumption and production is a major contributor to the rise in atmospheric greenhouse gases, according to the most recent IPCC report (IPCC, 2022). Resources become scarce and need to be stretched further due to an increased world population, making responsible resource management more important (Carruth & Grosse, 2022; Convention on Biological Diversity, 2020). In addition, a disproportionately low amount of the world's population is responsible for a majority of the resources consumed, and thus the emissions related to the consumption (Ritchie, 2018). Consequently, there is a call for new consumption and production patterns that are in line with the commonly agreed goals of sustainability[1] (Sustainable Development Goals [SDGs]) set by the UN (United Nations, n.d.). One concept that is considered possible to enable a more efficient use of resources is circular economy (CE). It is defined as a regenerative system, where resources, waste, emissions and energy leakage are minimised by narrowing or closing the material loop (Geissdoefer et al., 2016). It is argued that it would allow the transition from the linear "take-make-waste" pattern of consumption and production to a circular pattern (Remøy et al., 2019). Furthermore, instead of discarding resources after their initial lifecycle, CE aims to extend the life cycle of materials and by-products through methods such as sharing, reusing, repairing, refurbishing, and recycling (Gupta, et al., 2019; Souza, 2013).

The construction industry participates in the problematic way resources are consumed and produced, for example, it accounts for 35% of the European Union's (EU) waste generation and 50% of the extracted materials (European Commission, 2020). In addition, the industry is considered to be highly fragmented and slow to adapt innovations and climate effective practices. This is due to the fact that the development is based on market demand, economic cycles and trends (Almeida & Solas., 2016). The commitment to incorporate sustainable practices into construction projects is seen to be increasing (Zuo et al., 2012). Indeed, progress has been made regarding the environmental impacts from operations of buildings, where the energy efficiency for the usage of new buildings is improving (Cabeza et al., 2014). However, less progress is seen for the embodied environmental impact[2] of buildings, related to the life cycle of building materials. The life cycle of materials in a building encompasses all stages, from production to waste (Nußholz et al., 2019). Each stage of the life cycle has an impact on the final carbon footprint of the building and all stages

[1] *Sustainability* is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" by the United Nations' Brundtland Commission (Brundtland Commission, 1987)

[2] *The embodied environmental impact* is defined as: "Total impact on the environment resulting from the sourcing, transporting, processing and manufacturing of all the raw materials, fuels and items that contribute to the production of a good or service" (EESC, n.d.).

are important to consider in order to gain a comprehensive view of the overall efficiency related to factors such as final costs, both monetary and environmental (Moncaster & Symons, 2013).

A solution to reducing a building's carbon emissions is thus considered possible by transitioning a building's life cycle to a circular construction model and closing its material loop (Dong et al., 2021). A circular economy can according to Ellen Macarthur Foundation (2021) be incorporated to the construction industry based on two main principles: by eliminating waste, and by circulating products and materials. This can be accomplished through utilising by-products and waste materials as new input materials, referred to as secondary materials. Hence, the process of utilising secondary materials is commonly known as *reuse*[3]. Reuse is a method defined on EU level, such as in the waste framework for preventing material extraction and waste, referred to as the "waste hierarchy" (see Figure 1). Its objective is to create waste management principles, so as not to endanger human health or harm the environment by transforming waste into secondary materials (European commission, 2023). The main purpose is to prevent generation of waste, if not possible, then reuse is the alternative step followed by recycling, recovery and lastly disposal of waste.

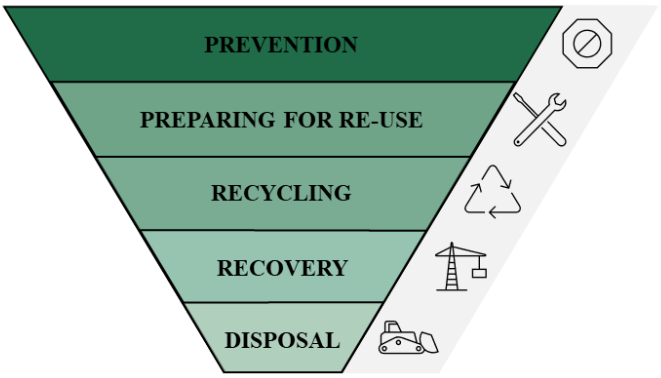

Figure 1: The Waste hierarchy. Model inspired by European commission (2023).

The construction industry in Sweden has been pushing the boundaries by initiating new methods that are in line with the frameworks set on EU level (Anund Vogel, 2020). Reuse is getting a more prominent role in construction projects, where there are completed and ongoing projects that have saved money in material cost as well as reduced the CO_2 equivalents by reusing construction materials and by-products (e.g., Nyhlin, 2023; Andersen et al., 2020). It is also suggested to have monetary and CO_2 saving potential if a large-scale reuse market were established in Sweden (Wennersjö et al., 2021; Andersson et al., 2021). Reuse is thus considered to be a method that can offer smarter resource management with the possibility of reducing the climate impacts of the construction industry, saving monetary costs from acquiring materials, and decreasing the need for

[3] The term *reuse* is defined by the European Parliament (Directive 2008/98/EC) as 'any operation by which products or components that are not waste are used again for the same purpose for which they were conceived'.

virgin materials (Leider & Rashid, 2016). However, incorporating reuse faces a variety of challenges, making it difficult to implement (Nußholz et al., 2019).

The challenges in combination with the fragmented industry might, as a consequence, make it hard for actors to understand the framework and how to implement reuse in their projects. In situations where companies lack in-house knowledge or capacity, hiring consultants can be a possible solution. Consultants usually occupy a wide range of expertise for all stages of construction, from planning, execution, to management (Andersen et al., 2020). The expertise can thus be used to apply alternative solutions such as reuse, and consequently benefit the project in decreasing the environmental impact and lowering the material costs.

The big Swedish consultancy companies within architecture and engineering have gathered a variety of professions and expertise that are interlinked with construction. They have according to their own marketing adopted and commonly include "circular construction" as a future "mindset", where consultants try to include and help their clients with implementation of methods such as reuse (Sweco, n.d.; WSP, 2023.; Thyréns, n.d.). Sweco is one of Sweden's largest consultancy firms within the industry. They consider themself as fervent advocates of sustainable construction and state that sustainability is embedded into their core offering and connected to their pursuit of profitability (Henriksson & Grunewald, 2020). Considering their size in the industry, Sweco has the ability to influence the market for reuse. Hence, there is a need to investigate how consultants can use their expertise to implement reuse in projects so that it benefits the client in both economic and environmental costs.

1.1. Aim and research questions

This thesis explores the opportunities and challenges associated with the implementation of reuse as a circular method in the Swedish construction industry, specifically with connection to the role of consultants. This is based on the following research questions:

1. How do different actors in the construction process understand sustainability, more specifically, circular construction and reuse?
2. In light of the above, what do the actors perceive as challenges and opportunities for implementing reuse?
3. In order to realise reuse and circular construction, what needs to be improved and what is the role of consultants in relation to this?

In addition to the above, the thesis will formulate possibilities for consultants to promote sustainability through reuse. This is done by giving concrete recommendations that aim to make reuse beneficial for all actors in the construction process.

1.2. Delimitations and assumptions

This thesis is conducted in cooperation with the consultancy company Sweco, more specifically on the management department for construction and real estate at their office in Stockholm. The thesis is built on the premise that reusing material has the potential to make construction projects more resource efficient, which in turn could decrease the buildings' embodied environmental impact, specifically in terms of greenhouse gas emissions and resource use. Additionally, whilst the thesis is focused on reuse in connection to buildings, it could also be applied to infrastructure, however this is not a part of the subject area. Further, circular economy is used as a framework to understand reuse. Hence, the assumptions are not that an incorporation of a circular economy through reuse entirely will replace the current system, nor remove the need to acquire newly produced materials. It rather focuses on the emergence of reuse as a circular method in construction, to further understand how it better can be implemented and understood from a consultant’s perspective in favour of decreasing the industry’s climate impact. Focusing on a consultant’s perspective, more specifically, on Sweco as a consultancy firm also depends on an assumption that consultants have an ability to influence the construction industry based on their size on the market.

2. Approaching Circular Economy and Reuse in Construction

The following chapter provides an understanding of how buildings and the construction industry are related to the circular economy. This works as a baseline to further understand reuse and its relation to stakeholders in the industry, and more specifically, to consultants.

2.1. The life cycle of a building

To understand the environmental performance of buildings, there is a need to consider the building's entire lifecycle. Methods such as *life cycle assessments* (LCA) are helpful to highlight the *embodied environmental impacts* of buildings, which is an important basis for sustainable development in construction (Moncaster & Symons, 2013; Hasik et al., 2019). In order to make these assessments, the life cycle of a building is divided into four phases. These steps can be described as; (1) *produce*, the processes including raw material extraction and its transport and manufacture, (2) *construct*, which is the transport of construction material and its installation, (3) *use*: maintenance, repair and refurbishment of the building, and (4) *end-of-life*, which varies between processes of demolition, waste management, disassembly, and transport according to the European standard (BS EN 15978:2011; Boverket, 2019).

Waste is generated through the entire life cycle, as indirect waste during the planning and design stage or direct waste as a consequence of the building process and operational maintenance (Esa et al., 2017). Certain components in materials hold value and can be reused into secondary materials. The primary building materials reused are concrete, bricks, wood, glass, metals and plastic (European Environment Agency, 2020). Waste management, if not considered during the early stages of a project, will minimise the project's efficiency and increase its overall environmental impact (Esa et al., 2017). Waste is defined as a substance that is perceived to no longer hold any value and as a consequence becomes discarded. This might result in unnecessary loss of materials and energy, since many of the materials categorised as waste still hold value and could be useful after its initial life cycle (European Environment Agency, 2020). Alternatively, by disposing of material, it may result in a negative environmental impact as it could be placed in a landfill that occupies space and causes air-, water-, and soil pollution, or if incinerated, it destroys the material and causes air emissions (Eurostat, 2023). Sweden has seen improvements in waste treatment with a 76% decrease in greenhouse gas emissions since 1990. However, the emissions still mainly come from landfills, other contributors are incineration of hazardous waste and treatment of biological waste (Naturvårdsverket, 2021).

2.2. Understanding circular construction

The concept of *circular economy* is considered to be an opportunity to reduce the environmental impact from all stages of a materials' life cycle (Ellen Macarthur Foundation, 2021). The current management of resources is characterised by an open loop system, meaning that natural resources continuously are produced and utilised, leading to depletion of natural resources and excessive emissions and waste (Gupta et al., 2019). Thus, researchers call for a switch of the current consumption model and closing the material loop (Ellen Macarthur Foundation, 2021). This would, according to Almeida & Solas (2016), enable the possibility to decouple growth of the economy from use and extraction of new resources. However, Hickel & Kallis (2019) disagree as they have not found evidence on the possibilities to decouple resource use combined with continued economic growth on a global scale, particularly at the rate required to prevent global warming above 2°C. Vaden et al. (2020) has found examples of decoupling between greenhouse gas emissions and economic growth in wealthier countries during limited periods for certain sectors. However, not on an international or global scale, where instead, evidence of increased material intensity and recoupling has been observed.

Applying the circular economic model to the lifecycle of buildings is considered by Wahlström et al. (2021) as an opportunity to reduce the embodied impact from buildings. The life cycles can from this perspective become one closed system, where the value of materials is utilised much longer (Gupta et al., 2019). In this thesis, the ideas of applying circular economic models on the construction industry is referred to as *circular construction*. Based on this, a suggested division of the life cycle of building materials is presented by the European Environment Agency (2020). The process is divided into five stages: (1) *recycling*[4] *and product manufacture*; (2) *design*; (3) *construction*; (4) *use and maintenance*; and (5) *end-of-life and demolition* (see Figure 2).

[4] *Recycling* is defined as 'any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes' (Directive 2008/98/EC).

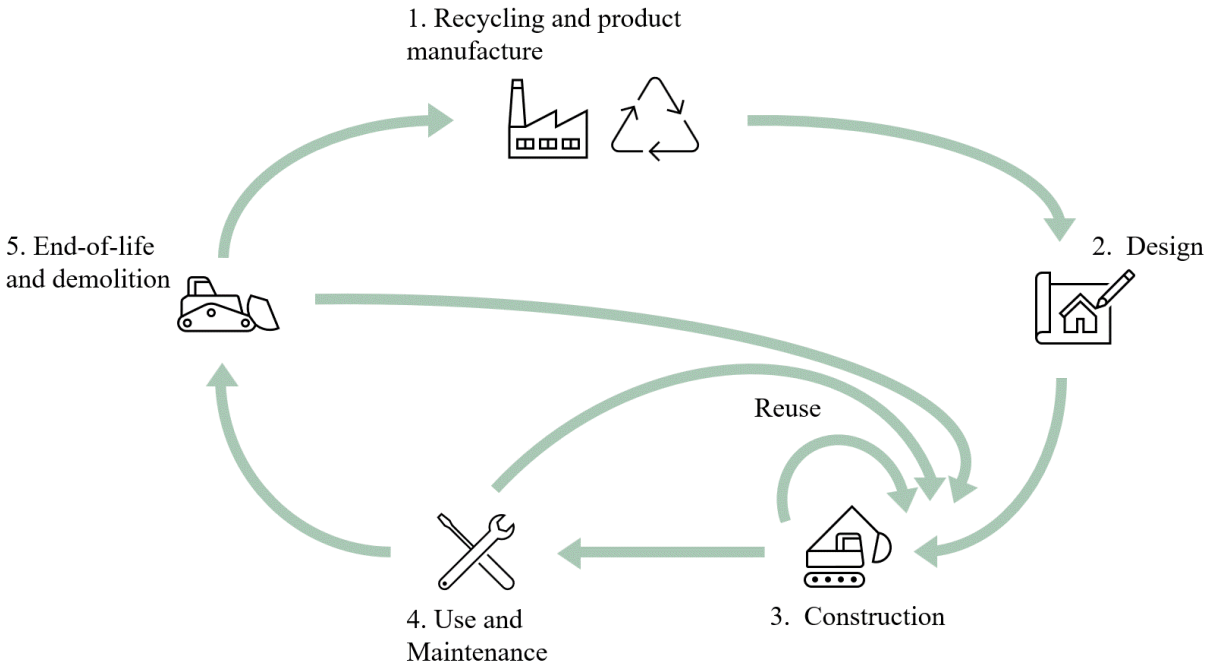

Figure 2: The building's life cycle from a circular construction perspective. Model inspired by Wahlström et al., 2021.

The objective of a circular construction model is to move away from a linear model into a circular model, where synergies can be enhanced in the different stages of a construction project. For example, this means that waste or by-products from one level of the cycle can be input materials in another, reducing waste and enabling a better use of resources (Souza, 2013). To properly close the loop, all stages of a building's life cycle need to be considered. Wahlström et al. (2021) evaluated the possibilities and gave the following suggestions: the (1) *recycling and product manufacture* is the primary stage to close the material loop, through improving recycling technologies and the logistics around collecting and cataloguing materials. The (2) *design phase* of a building must include possibilities for disassembly, easy maintenance, *adaptive reuse*[5] and improving the overall lifespan. The (3) *construction phase* could be improved through better knowledge on resource management and sustainable materials. The (4) *use and maintenance phase* focuses on prolonging the lifetime of a building through refurbishments, maintenance and adapting reuse in order to avoid demolition and reconstruction. Lastly the (5) *end-of-life and demolition phase*, if required, should save, and repurpose all materials and products that hold value at end-of-life through recycling and primarily reuse. In this framework, *reuse* becomes applicable from the construction stage with materials from the latter stages in other projects (see figure 2). The suggested concept proposed by Wahlström et al. (2021) sets a framework on how the industry could apply a circular approach when considering the construction phase, operation, and end-of-

[5] *Adaptive reuse* refers to situations where the purpose and usage of a building is transformed to another context, such as the transformation of a factory to an office (Hasik et al., 2019).

life. Each step has its own challenges and opportunities but is considered flexible and can be adapted to meet the demand of each project depending on context (Wahlström et al., 2021).

Corvellec et al. (2021) criticise CE and its attempt to be deliberately vague and uncontroversial. By phrasing related policies as consensual win-wins without considering or showcasing the actual economic, social and environmental benefits makes it difficult to scrutinise (Aguilar-Hernandez et al., 2021). This vagueness could benefit policymakers as they focus mainly on strategy, however, this does not take the issues of transitioning from a linear economy into consideration (Völker et al., 2020). This translates into difficulties for initiatives and companies to implement policy makers' suggestions on CE as they are not clearly understood or practically feasible (Corvellec et al., 2021). This can also be visualised in the number of definitions for CE, as over 100 has been inventoried, consequently causing confusion and that the term has different meaning to different people (Kirchherr et al., 2017). There is no single accepted term for CE, but instead different definitions are sharing the concept of "decoupling natural resource extraction and use from economic output, having increased resource efficiency as a major outcome" (Mavropoulos & Nilsen, 2020). Comparisons can be drawn to terms such as 'sustainable growth', 'green growth' and 'sustainable development' (Völker et al., 2020). As such, CE can be subjected to associated criticisms. In particular, an increasing number of researchers question the notion of green growth, pointing to the lack of real-life examples of absolute decoupling between environmental impact and economic growth (Hickel & Kallis, 2019; Vaden et al., 2020)

The varying definitions of circular economy makes companies' initiatives and interpretations of related policies uncertain. Additionally, there is an increased public awareness of society's environmental issues among stakeholders (Chen & Chang, 2013), as a consequence, some companies can be seen as investing in so-called "green marketing" strategies to become perceived as environmentally friendly (Nyilasy et al., 2014). Consequently, this might lead to companies introducing green strategies that do not necessarily emphasise the environmental impact issue, something that is commonly known as "greenwashing" (de Freitas Netto et al., 2020). Therefore Kirchherr et al. (2017) argue that using an undefined concept such as CE as a "buzzword" in conjunction with sustainable development or green growth can be considered problematic. Since the concept of circular economy in the construction industry has varying definitions on terms and methods, there is a need to further clarify their meaning and how they are related to each other. In order to make the most of its potentials, the sections below clarify the defined solutions, potential challenges and opportunities found in the literature as well as their limitations.

2.3. Understanding reuse

Reuse is often confused with recycling. While reuse and recycle share similarities, this report only refers to the process of reuse. In Sweden, reuse is referred to as *återbruk* and is commonly used as a way to highlight sustainable construction, however, definitions vary between projects and different contexts. For instance, some actors also include the use of waste products and materials for defining reuse (Glasare & Haglund, 2022), something that shares more similarities with what is defined as recycle accordingly (Directive 2008/98/EC). Furthermore, since there is room for interpretation regarding what is defined as reuse depending on what premises it has been used, it is considered necessary to be transparent regarding how a project has been arguing for its use (Glasare & Haglund, 2022). For example, if reuse is implemented in a new production, the climate impact of the reused material's life cycle is calculated as zero according to Swedish standards (ibid). However, this standardised calculation does not take processes such as re-conditioning, transport and stockpiling into account (Gerhardsson et al., 2020). Therefore, despite the potential of reuse, its reduced climate impact might get undermined if for instance the secondary material requires long transports or large transformations that makes the benefits lower compared to new materials (Vadenbo et al., 2017). Consequently, de Freitas Netto et al. (2020) mentions how it in certain contexts would be more climate beneficial to purchase virgin materials rather than to reusing secondary materials.

Regarding the overarching, formal, definition of reuse, the term can be seen as ambiguous considering how loosely it is used in practice. To further understand in what contexts reuse is implemented in, the varying processes need to be defined. *Retrofit, refurbishment and renovation* are used interchangeably. *Retrofit* is the process of improving performance in an area, such as energy efficiency or by adding features that were not included in the original construction (IHBC, 2022). Retrofit is not of relevance for this thesis. *Refurbishment* and *renovation* are commonly used to describe the process of modifying and improving existing buildings to increase their living condition and energy levels to a modern standard. Which of the definitions to use mainly depends on region and context, where European standards use the term refurbishment (Swedish Institute for Standards [SIS], 2011), and the North American region uses renovation (Hasik et al., 2019). When describing the modification and improvement of existing buildings, it is referred to as r*efurbishment* for the rest of the report. Similarly, *adaptive reuse* is used in the report to describe the transformation of the purpose of the building (Hasik et al., 2019).

Within the framework of this thesis, specific definitions have been chosen to provide consistency in the report. Firstly, the thesis' main focus is on reuse from a Swedish context. Therefore, the thesis is based on the Swedish term "*återbruk*" which is restricted to the definition set by the European Parliament (Directive 2008/98/EC). Similarly, the incorporation of reuse is in this thesis

including projects for new and existing buildings, as well as refurbishment projects. Hence, how reuse is applied in projects is restricted to three ways:

- Construction of new buildings, where secondary materials are bought or collected from other projects for reuse.
- Adaptive reuse, maintenance, and refurbishment of buildings, where secondary materials are bought or sold for reuse, or reused within the project.
- Demolition and deconstruction, where materials are sold or distributed to other projects.

2.4. Stakeholders and the role of consultancy companies

There are several stakeholders and interest groups involved in construction projects and the amount can vary between projects depending on context and size. However, certain key stakeholders are always involved and necessary for the implementation of construction projects (Oppong et al., 2017). Internal stakeholders or those directly involved in the project includes the client, project manager, design teams, contractors and chosen consultants (Rahman, 2022). Each stakeholder invests capital in the form of time, resources or financial backing and as a result, these stakeholders can influence and shape the progress of any project. This push and pull relationship between stakeholders have a significant impact on the construction sector and the entire value chain (Jin et al. 2017). Similarly, each participant is exposed to different potential risks throughout the lifecycle of a construction project; how they approach and manage this risk is dependent on the participants' characteristics (ibid).

Consultants have the opportunity to offer expertise and competencies for all or certain stages of the construction process. According to Henriksson & Grunewald (2020) consultancy firm's objective is to deliver knowledge and solutions. Equally, consultants should propose alternative solutions to clients, as they might have knowledge that could be beneficial and promote a long-term perspective (ibid). This includes trends and innovation which are according to Almeida & Solas (2016) primarily dictated by market demand and economic cycles. Companies and projects that recognize trends, adapt to challenges and utilise opportunities will benefit the most (ibid).

Through internal structural improvements, Sweco has set internal climate goals of halving their climate impact from 2020 by the year 2030. The primary reduction will be accomplished through projects on behalf of their clients (Sweco, n.d.) in combination with acknowledging the possibilities of circular economy as a method to reduce climate impacts, reduce construction and demolition waste and save costs (Carruth & Grosse, 2022). Another way Sweco intends to ensure its sustainability commitment is through decentralised management which empowers consultants to solve the customer's demand and simultaneously develop a business relationship. Essentially, making the consultants the building blocks of the organisation, encouraged to do business and enabling their individual freedom with the backing of the company's resource and knowledge pool (Henriksson & Grunewald, 2020).

3. Methodology

This chapter introduces the methodology of the thesis as well as methods used to collect, process and analyse the empirical data. Lastly, the chosen methods are discussed regarding their truthfulness and ethical consideration.

3.1. Methodological approach

This study follows an iterative approach which, compared to inductive and deductive approaches, is flexible in its structure and analysis (Tracy, 2018). The thesis is therefore formed and developed during the process of writing. The analysis is based on three questions: what the previous research tells the researchers; what do the researcher want to investigate based on the research questions and previously stated aim; what does the data showcase in relation to what the researcher want to know and how is the aim revised to match the research questions (Srivastava & Hopwood, 2009). In other words, the iterative approach goes back and forth from analysing existing research to examining the gathered qualitative data. A general idea of the research problem has therefore initially been developed, this is then explored from different angles through interviews with respondents of varying experience and roles. This leads to different aspects and perspectives with problems and solutions relevant to them (Tracy, 2018).

Based on the iterative approach, this study is conducted with a qualitative data collection through a combination of researching previous studies and conducting semi-structured interviews. Since the aim of the study is structured around getting an understanding of how consultancy companies work with reuse and its potential improvements, it forms research questions that are relatively open. Consequently, MacCallum et al. (2019) argues that qualitative data is the most suitable. Further, using a qualitative approach is argued to be applicable when there is a need for in depth and detailed information about the problem.

3.2. Data

In line with an iterative approach, the existing research and empirical data have been examined in parallel. A literature review was conducted to highlight potential challenges and opportunities regarding the implementation of reuse as a method aiming to make the construction industry circular. A literature review is as argued by Hart (1998) as being an essential part of a research paper to be able to understand the topic and present previous findings on how the subject has been researched, as well as key issues covering the topic. For this thesis, the literature has also worked as a way to complement the analysis to provide a framework of how consultancy firms within the built environment can better offer circular construction such as reuse to their clients. The terms "reuse", "circularity", "circular economy/construction", “construction industry”, and

"stakeholders" were all keywords when searching for articles in scientific databases, used in combination and by themselves. The databases used were Primo, Scopus, Science Direct, and GreenFILE. It was decided to choose articles that showed relevance to the current state of reuse in the construction industry. Therefore, most of the articles regarding the reuse and circular economy were aimed to be from 2018 and onwards.

The empirical data was primarily retrieved through semi-structured interviews. Considering the aim, interviews are a helpful tool to retrieve information, opinions and perspectives from people with special knowledge and experience of certain phenomena (MacCallum et al., 2019). The semi-structured take means that the interview is based on already set questions to guide the interview. Compared to a structured interview, the respondents have a flexibility to talk freely on each question which is in turn asked openly. This gives the freedom to explore new discussion topics as they emerge and allows for follow up questions to dictate the discussions direction (ibid). Semi-structured interviews also work better when the respondent's main function is to provide information from the perspective of their profession, meaning that less weight is put on the individual perspective and personal opinions, but rather on their role as a professional (ibid).

3.3. Choice of respondents

Due to the nature of construction projects' individuality, given that each project requires a different amount of planning, financing and effort to implement, there are many different stakeholders involved. Because of this, it was deemed valuable to interview actors with different roles covering all stages of development. At the end of each interview the respondents were given the opportunity to suggest additional interviewees. These were either colleagues or interesting professions that were not already included. This meant that certain individuals were not a part of the initial sampling, but they all had knowledge or experience with reuse. The sampling can therefore be divided into two types, expert sampling and snowball sampling. The expert sampling is based on finding interviewees that have an expertise in a certain research topic (MacCallum et al., 2019). In this case, it refers to participants that have an initiative role in implementing circular construction methods such as reuse, but also internal experts on the topic. The snowball sampling is when the interviewer asks the interviewees for recommendations of other suitable interviewees (ibid). Therefore, two parts were made with the participants from the expert sampling, one to get an insight in their work and to get recommendations of actors with different roles in the projects. The second interview was the one used as empirical data. The participants from the expert sampling are all employed at Sweco, meaning that all of the participants that were recommended had a relation to the consultancy firm, such as contractor, entrepreneur, or property owners.

Additionally, all of the respondents have a relation to the construction industry and in projects where reuse have been conducted in some way. The interviews were held between the beginning

of March and the middle of April 2023. *Table 1* gives an overview of the respondents. The majority of the respondents are employed at Sweco, of which most of them work as consultants, either at different projects or with different roles. The respondents who are not employed at Sweco have different professions, such as contractor, sustainability coordinator and developer. There is also a variety in the type of company they are employed at, such as one publicly owned real estate company, one private real estate company, one private construction company and one waste treatment plant (see *Table 1*). Each respondent is anonymised and is referred to as A-L throughout the report.

Table 1: Respondents.

Respondent:	**Role**	**Company**	**Type of company**	**Date**
A	Project manager	Sweco	Consultancy firm	2023-03-20
B	Project manager	Sweco	Consultancy firm	2023-03-16
C	Construction manager	Sweco	Consultancy firm	2023-03-08
D	Architect	Sweco	Consultancy firm	2023-03-20
E	Circular economy specialist	Sweco	Consultancy firm	2023-03-13
F	Sustainability consultant	Sweco	Consultancy firm	2023-04-03
G	Waste management consultant	Sweco	Consultancy firm	2023-03-06
H	Environmental controller	Käppalaförbundet	Municipal waste treatment plant	2023-03-16
I	Developer	Käppalaförbundet	Municipal waste treatment plant	2023-03-03
J	Research- and innovation coordinator	NCC	Construction company	2023-03-17
K	Chief of sustainability	Akademiska hus	Public real estate company	2023-03-22
L	Sustainability manager	Castellum	Private real estate company	2023-04-13

3.4. Conduction of interviews

The aim was to conduct a majority of the interviews in person to achieve as much as possible from the respondents. It resulted in six in-person interviews and seven conducted through Microsoft Teams. A negative aspect of doing digital meetings is that the dynamic between the interviewer and respondent might be lacking as well as the level of concentration could be lower compared to when the meeting is made in person (Hallin & Helin, 2018). This could potentially affect the outcome of these interviews and should be noted. Two of the interviews included site visits to the projects that the interviewees were working with to further get an insight into what the project was about. The interviews have been conducted in a variety of environments. Either in the office of the interviewee, in a cafe, or online, something that could affect the responses. All interviews started with an introduction to the thesis' topic and aim. The respondent then provided a brief introduction to themselves, their occupation, and their professional background.

As shown in *Table 1*, the interviewees have different roles and experiences, and additionally are working in a variety of projects that are in different stages. Therefore, the questions were formulated based on the person interviewed. To further get a consistent analysis of the data, the interviews are based on three overarching themes and seven sub-themes in which the questions are formulated (see Table 2). The interview-themes are partly based on the report's aims and research questions and partly on the information gathered from the literature review. The themes have later been used to structure the empirical evidence in the results. Additionally, the themes have worked as a tool to conduct the analysis. With the themes in mind, the introductory questions were broadly formulated to get an understanding of the interviewee's view on sustainability within the construction industry based on their profession. Thereafter the interviews got into more detailed questions regarding how reuse has been thought of and included in their projects, as well as potential barriers with implementation based on the demand. A more detailed template of the questions asked is shown in the interview guide in the appendix.

Table 2: Themes and sub-themes used as the basis for the interviews.

Themes	**Sub-themes**
Views on a Changing Industry	Circular construction
	Definitions of Reuse
Demand for Reuse	Current circumstances
	Potentials
	Challenges
Improvement Areas	Cooperation
	Ability for consultants

All interviews were recorded after an oral consent from the interviewee. The recorded material has thereafter been transcribed to work as data for the analysis. By transcribing the interviews, the interviewer gets an overarching compilation of the gathered responses and enables the analysis of the material (Saunders et al., 2015). Notes were additionally taken from each interview to further gather the most important parts of what was discussed and facilitate the compilation of the data. Additionally, the interviews were carried out by two master thesis students, the role of note taker and interviewer were switched between each interview. This could offer a more detailed take on the analysis as well.

3.5. Thematic analysis

The process of collecting data was conducted by identifying patterns and themes in the respondents' answers. Therefore, a thematic analysis was deemed the most suitable method (Braun & Clarke, 2006). Braun & Clarke (2006) describe a thematic analysis as a flexible analytic tool to identify patterns and create a detailed narrative for complex information. Denscombe (2018) means that the thematic analysis focuses on the content of the research findings combined with the insights found from previous research. It similarly aims to find a consensus in the studies that are examined, such as if there is a general view among the respondents in certain aspects that are brought up. Additionally, it also aims to highlight eventual differences in views among respondents and identify within what subjects these differences are concerning.

The empirical material from the interviews was recorded and later transcribed. The first stage of finding patterns was done by reading through the transcribed material and dictating the main points brought up by each respondent. The first step is called coding which is done by finding keywords that highlight similarities in what was said and what the author considers interrelated. The method enables the researcher to get to know the material and find similarities and differences in the empirical data (David & Sutton, 2016). The codes ranged from overall concerns to specific actions such as problems they have experienced, or solutions encountered. Similarly, the topics were related to concepts, similarities, processes, differences and methods. The coding has been done with what is found in the literature in mind, based on the set themes and sub-themes. At the same time, the coding has also aimed to be relatively open to find new patterns without having the interview-themes in mind in order to find new patterns not mentioned in the literature. In this sense, the type of coding can be seen as a combination of a more open structure (inductive) and a theory-based (deductive), known as abductive (Vila-Henninger et al., 2022).

Also, certain parts were marked if they resembled points brought up in the previous studies. The identified patterns could thereafter be grouped into different themes where similarities and differences within certain aspects were identified. A theme can be described as an aspect that the

researcher finds important in the empirical data and is relatable to the research questions (Braun & Clarke, 2006). The themes are in other words not based on how many times a certain code is repeated, but rather how it is relevant in relation to the research. The researcher thus has an active role in defining what the themes are from the collected codes (ibid). In this report, the already set interview-themes (Table 2) is used as a template for presenting the results. Chapter six "Analysis and Discussion" then ads on and combines the findings from the results with the literature, giving it another structure.

There are certain limitations when conducting a thematic analysis on empirical data, being that there is no clear definition of the concept and its delimitations (Bryman, 2011; Braun & Clarke, 2006). Braun and Clarke (2006) argue that a thematic analysis is restricted when it comes to interpreting the material and is rather more suitable for just describing what has been said. Additional methods could have been utilised to add legitimacy to the interpretation of the results such as including a discourse analysis (ibid). However, basing the results on previous studies and key concepts was considered adequate to interpret and understand the data in light of the project's aim. The previous research is therefore of great importance to base the interpretation of the results on.

3.6. Methodology discussion

The truth value of the collected data depends on its relevance towards the stated aim and research questions of the paper and is in this case dependent on what information was gathered from the interviews (Denscombe, 2018). As interviews have been the main source of data collection in the thesis, it became important to phrase the interview questions according to the research aim. Therefore, the interviews were phrased with the research questions in mind to easily link back the empirical data to the aim. A part of the formulation of themes and topics for the interviews have also been to avoid leading questions and instead begin with open general questions and go into details when considered necessary. This can further justify the consistency of the information collected from the interviews and later used in the results.

The thesis depends on the interviews as a data collection method. Therefore, the report is restricted to projects that the respondents are or have been a part of. These projects are mainly construction and refurbishment of public buildings such as schools, hospitals and offices, meaning no residential properties or buildings constructed by private citizens. On the other hand, the thesis is not dependent on specific building projects, but rather focuses on professional insights and experiences from the respondents. This means that the type of project is not of great relevance for fulfilling the aim and answering the research questions.

A research paper can to a certain degree be seen as reliable if the same results and outcomes can be obtained in another study conducted at another time but with similar premises (Denscombe, 2018). However, as the topic of reuse and circular construction is relatively new and untested within the industry, there are large scientific gaps and much has not been researched. Reuse within construction is in practice still at an early stage, if an identical study was conducted at a later date when reuse is more standardised, different results might be given. Additionally, the interview questions vary between respondents based on their profession and the overarching themes. Equally, this means that the responses are dependent on the interviewer, as it cannot be assumed all interviews will follow the same structure and ensure the same level of objectivity. Other codes and themes could therefore be obtained if another researcher would have done this study (Larsen, 2018). The degree of consistency can be justified by how well the researcher argues for the choice of data collection and the reliability of the analysis (Denscombe, 2018). It is therefore of great importance to justify the choice of methods, analysis and decisions throughout the thesis.

3.6.1. *Presentation of data*

How many interviews required for a qualitative study is dependent on the purpose of the study. As this study investigates perspectives from a wide variety of actors from different stakeholders involved within construction, the aim was to get insights from at least two actors with the same profession. At the same time, Denscombe (2018) argues that since qualitative studies are made with a limited number of cases, such studies cannot be generalised the same way as quantitative studies. To make studies relevant and applicable for other contexts, certain relevant details are needed to draw a comparison on, such as profession, age and experience. Furthermore, because of the limited time frame of the thesis, the number of interviews becomes restricted. In order to make a more nuanced study, more time would have been needed to have more interviews and gain a greater insight from a large variety of perspectives. This includes people working with demolition and construction waste, the demolition process and municipal officials. Therefore, the thesis answers the research questions in an overarching way but could be investigated further. Which would be desirable since many new questions are discovered during the research.

Another important aspect when presenting and analysing qualitative data from interviews is to ensure that the responses are presented and interpreted in a not distorted fashion. Since the empirical data cannot be presented directly from the interviews, the reader needs to be sure that the presented results are aligned with the respondent's answers. For example, quotations need to be as literal as possible and not taken out of context (Denscombe, 2018). This is partly ensured by providing background information of each respondent and context when quotations are used. On the other hand, all interviews have been held in Swedish, where quotations have been translated to English. Therefore, a complete correct translation of what the respondents have said cannot be ensured, which is where the results could be lacking in transparency.

3.6.2. *Ethical consideration*

As previously stated, this thesis is made in cooperation with Sweco and aims to provide an understanding of how reuse is perceived, the challenges and opportunities associated with the use of secondary materials. The results should ideally provide suggestions for how consultants can provide sustainability through reuse. The department *regional management of construction and real estate* at Sweco has assisted by giving connections to relevant actors and information on projects where reuse was utilised. Additionally, they have shared professional experiences and offered guidance. The company has thus provided sources of materials useful for data collection as well as interview candidates, both of which has made the study possible. The cooperation also includes a presentation of the final results for the department, where the expectations from the company indirectly could affect the final outcome of the study. By collaborating with Sweco, we worked at their office irregularly, at the same time as we got invited to participate during meetings, lectures, field visits and lunches. This could also have had an indirect effect on how the collected material is presented and analysed (Kvale & Brinkmann, 2014).

During data gathering, it was attempted to do it without affecting the respondents' answers. This is based on the principles explained by Denscombe (2018), where interviews are conducted in a way so that the interests of the respondents are secured. The respondents are not mentioned by their name throughout the text, and since the questions are phrased from the perspectives of their profession, their individual values and interests are avoided as much as possible. This is in line with the current General Data Protection Regulation (GDPR). However, since the thesis mentions positions within the companies, it can be possible to trace who they are. In these cases, the respondents in question have been informed and are aware of it as well as giving their consent. Additionally, it was guaranteed that the interviews were voluntary. Prior to the start of each interview, the interviewees were informed, and their consent was obtained regarding how their personal details are handled and their right to revoke their contribution. To further ensure that the respondents were aware of what their responses are used for, each interview started with an introduction of the thesis, explaining the aim, objectives and expected outcome. In addition, it has been informed that the thesis will be published on an open source and accessible for the ones included.

Considering the cooperation and dependency of Sweco for making the study possible, it should be noted that the overall goal of the thesis is to make a report in line with ethical and scientific principles. Even though certain types of deliverables could be argued for being required from the company, the ambitions have been to critically analyse the company's role critically and objectively as an actor in the construction industry and their potential to work with reuse as a circular construction method.

4. Indicated Challenges and Opportunities in Literature

This chapter gives a review of the identified challenges and opportunities related to incorporation of circular construction methods and reuse mentioned in the literature. The brought-up aspects are later used to analyse and support the results.

The idea of incorporating a CE in the construction industry is at the early stages of development, partly due to the difficulties in realising such methods in practice and the uncertainty of who should take responsibility for implementation (Carruth & Grosse, 2022). Korhonen et al. (2018) argues that the concept mainly has been created by policymakers and practitioners, where the scientific basis of the concept is relatively weak. On the contrary, Leipold et al. (2023) propose that the research regarding CE is focused on the concept and not on its real-world applications and process. There is therefore a need to combine the real-world practicality and feasibility with empirical implementations. Companies with business models that utilise secondary materials face several barriers. In the current linear structure, material prices do not reflect the externalities of waste generation and resource extraction, which reduces the economic benefits of purchasing secondary materials, prolonging the transition towards CE (Nußholz et al., 2019). In other words, when there is no established large-scale system, the financial cost of circular construction is expected to be higher for developers in comparison with continuing with the current linear structure (Gupta et al., 2019). Similarly, Kraaijenhagen et al. (2016) describes the main challenge of implementing CE as how to maximise the value of secondary materials and by-products.

Four additional barriers are considered by Nußholz et al. (2019) being: (1) a limited market with small margins for profit; (2) low accessibility to adequate quality and quantity of secondary materials; (3) a non-established system for reconstruction and collection of secondary materials; and (4) few dominant actors responsible for waste and resource management with low interest in cooperation. Moreover, a large amount of the secondary materials is not suitable for reuse within a closed loop, due to construction practices from the past and a lack of high quality materials being generated from demolition and refurbishment (European Environment Agency, 2020). Additional issues raised by Carruth & Grosse (2022) is the need for better information sharing regarding dimensions and quality of materials, similarly how secondary materials can be made available to share between actors. Consequently, as the demand for reuse increases, new construction policies and methods need to be developed (Nußholz et al., 2019).

The competitiveness of the construction industry is argued by Robinson et al. (2005) as dependent on the internal knowledge of the companies involved. When economic cycles are characterised by constant change, the knowledge within the company is argued for being an indicator that decides the company's success or failure (Leliaert et al., 2003). On the other hand, just maintaining knowledge is not considered enough in order to compete, it must rather be properly managed

(Davenport & Prusak, 1998). The idea of *knowledge management* is considered as a concept aiming to optimise the internal knowledge to create value and increase productivity to hold an advantage against competitors (Nakamori, 2020). It is thus argued for a need to constantly share and stay updated on knowledge among various stakeholders in the industry (Zhang et al., 2013). Knowledge management is therefore based on finding out what is essential, useful, and important knowledge to make rightful decisions that in the long term is beneficial for the company (Sommerville & Craig, 2006). Knowledge management can be seen as relevant for the context of circular construction. The lack of knowledge about CE among stakeholders is identified as a main barrier according to Mahpour (2018). Similarly, recovering secondary materials from dismantling of buildings is according to van den Berg (2020) based on implicit knowledge and experience among stakeholders. Therefore, the process needs to be easy and economically beneficial for the demolition contractor to execute.

Another challenge is the reasoning how new methods and techniques might lack acceptability among actors if they do not fit into their business model. This is defined by Gupta et al. (2019) as either goal- or perception conflicts. Goal conflicts being that different actors of the supply chain have different visions of what they want to achieve with their businesses. The perception conflict refers to how companies have different perceptions of sustainability. It is therefore suggested that a circular construction approach should be implemented as a collective solution. The issue being that it would not be financially feasible or environmentally beneficial if implemented individually, it is therefore considered necessary to be universally adopted to have a real effect (Antikainen & Valkokari, 2016).

Additionally, a successful implementation requires a mutual sense of responsibility between all stakeholders, from policymakers to all actors involved in construction (Lewandowski, 2016). With the industry being highly fragmented and responsibilities being split between actors, changing construction methods and implementing innovation is difficult. Consequently, innovation is hard to coordinate and manage between companies due to a lack of communication between actors, insufficient funding, and the slow pace of change within the industry (García, 2005). Joensuu et al. (2020) suggest a balance between top-down and bottom-up approaches, in other words, including both implementation of policies and grass root initiatives, to enable a switch to a circular life cycle for construction. Furthermore, there is difficulty in finding the "win-win-win" setting, explained as the balance between self-interests of the actors involved and the environmental impacts (Antikainen et al., 2013).

Hwang & Ng (2013) further highlight how the role of the project manager has changed when environmental aspects are more topical in projects. The management faces new challenges when there is a need to adapt to new requirements such as sustainability goals. The traditional role of managers is therefore challenged when new methods, techniques and materials are introduced. As

a consequence, managing projects might take longer as well as increasing the costs. In this sense, the role of project managers is argued to have expanded to also include requirements regarding sustainability. As an example, the increased awareness of resource efficiency in construction projects have made aspects such as reuse more relevant, which increases requirements in terms of planning projects (ibid).

There are a variety of suggested solutions for facing the challenges with implementing reuse in construction projects. Liu et al. (2021) argues that most excessive emission can be erased from the building process if the planning phase is conducted thoroughly and utilises all available environmentally friendly construction methods, digital tools and clear communication whilst also working towards clearly set goals. Similarly, Kovacic & Zoller (2015) explain how the emissions from the building's life cycle is determined in the planning and design phase, including decision of materials, on-site activity, and operational structure of the project, therefore, emphasising the importance of the early stages of projects.

Lingegård & von Olreich (2023) additionally suggest how a standardisation of design choices or concentrating products for reuse has the ability to enable decisions. Creating building modules that are easy to disassemble is one example. They further argue that to enable a more standardised construction process in favour of reuse, a more centralised governance structure of decision making in projects is needed. Similarly, Kirchherr et al. (2017) argue that public policy is one effective tool to successfully transition into a circular construction system. There are several ways to initiate this, a commonly used method in the EU is to use environmental taxation, by shifting taxes from labour towards pollution, energy, and resource use. By doing this, it is considered possible to generate revenue and also force actors to transition towards circular practices in order to stay financially profitable and competitive (European Environment Agency, 2016; World Bank, n.d.). Zu Castell-Rüdenhausen et al. (2021) justify in their report –investigating how national policies are supporting businesses that have a CE focus in the construction industry in the Nordics– how the construction industry is well represented in Swedish circular economic policies. In addition, their study shows how national policy instruments referring to planning, requirements for sustainable constructions, and requirements for public procurement are prominent drivers for circular economy initiatives in the Nordics.

Even though policies are great guidelines for implementation, Joensuu et al. (2020) argue that regulations cannot guarantee a successful implementation. As already problematised, if there is a lack of knowledge and expertise among stakeholders, the rightful effect of the objective might not be achieved. Such issues can on the other hand possibly be solved by established information platforms and database tools that enable and guide circular construction methods such as reuse (ibid).

5. Interview Results

The results gathered from the empirical data is presented in this chapter. The structure of the chapter is based on the three interview-themes and seven sub-themes that are formulated around the research aim and questions as shown in section 3.4.

5.1. Views on a changing industry

5.1.1. *Circular construction*

The view of sustainability and the construction industry's climate impact has become more prominent in construction projects and is incorporated into companies' strategies, something that all *respondents* can confirm. Although, there are different views on how the sustainability aspect has influenced construction projects. Sustainability as a concept is broad, for example, *respondent J* mentions how it is irrelevant to discuss sustainability on a project level and says how the industry should focus more on material and resource efficiency. Instead, they argue that the embodied environmental impact of buildings and materials should be the focus point and not sustainability as a whole. Both *respondents J and K* mentions how the emergence of climate change as an issue the previous ten years has been the key driver in recent developments. This is further justified since they believe that the main sources of emissions within construction being the production of materials and products, whereas the best solution is in a reduction of new construction whenever possible.

Respondents A, D and *H* explain the role of sustainability in the construction industry as how the overall awareness of how resources are used have changed, where people have realised the value of existing products and materials. Simultaneously, it is seen how this way of thinking is relatively new and not fully established, allowing many actors to continue as previously. *Respondent I* explain from his experience as a developer for a municipal waste treatment plant how they have an overall goal to make the climate impact of the business as low as possible which is fundamental for their operations. He argues that the emerging focus of sustainability is not relevant since the nature of waste treatment is already intertwined with impacting the climate to the lowest degree possible. *Respondent F* discusses how most organisations and companies want a “sustainability stamp” without knowing how to get it as they lack the competencies and experience. They Continue by stating that sustainable construction is about a need to be as updated as possible on sustainable measures, to be one step ahead of the competitors. Additionally *respondent C* argues how companies start projects looking at the financial perspective, adding the sustainability aspect much later. This leads to a low environmental effect and lost revenue due to the complication of adding sustainability measures late in projects.

Even though sustainability within construction is seen as an emerging concept, its focus has more specifically been on the shift of producing new materials to utilising existing ones (*e.g., respondent A, B, D, E, F, K). Respondent D* considers as an architect that the existing building stock needs to be preserved, appreciated and catalogued and that demolitions should be avoided as much as possible. Both *respondents B and K* see how the discussions have shifted from the process of demolishing and new production to instead refurbishing the existing building stock. *Respondent K* further explains how they as a property owner have switched from expanding buildings to whatever extent their tenants ask for, to evaluating how their buildings are being utilised and if an expansion really is required. The transition of rethinking the value of products and materials into a circular construction model to avoid demolishment and producing new material is further explained by *respondent E*:

> *"Firstly, you have to incorporate renewable materials, you have to build in chemical- and toxin-free materials because otherwise we can't circulate them later, you have to design for deconstruction, and lastly, you have to build with as much reused material as possible." - Respondent E*

These aspects are all seen as fundamental in the work towards circular flows in the construction industry. *Respondent K* tells of how Akademiska Hus has been trying to equalise financial gains and climate action by prioritising sustainability at the expense of economic gains in certain projects. Though admittedly this is partly due to the company's unique position as a state-owned enterprise dealing with educational and research real estate, meaning they have a stable income, low competition and are able to experiment with alternative construction methods. On the other hand, *Respondent J*, employed at NCC, explains that they are first and foremost a business, conducting economic activities and are driven by market demands. If a client wants to initiate reuse, NCC wants to come in early in the process to help plan the execution.

5.1.2. *Definitions of reuse*

A part of circular construction explained above, reuse of materials is something that all *respondents* have worked with. However how they view, understand, and implement reuse varies between them depending on profession and company. *Respondent B* divides reuse into two methods: reusing existing materials possible to disassemble and reusing as a way to sort waste through recycling of materials. On the other hand, *respondent E* points out the importance in distinguishing between reuse and recycling and clarifies that the sorting of waste material and recycling is not the same as reusing. *Respondent J and K* instead sees reuse as a general method to save resources by adjusting the purpose of buildings and rooms through adaptive reuse and refurbishment instead of demolishing. The different understandings of the concept reuse are further seen as misleading when it comes to practical implementation:

> *"It is easy to get caught up in semantics. There is a difference between reuse and circularity that is actually not so important. The main focus should just be to keep things where they are and not complicate things."* - *Respondent K*

It is instead argued more relevant to follow a systematic model for implementing reuse. For the sake of materials and products, if something cannot be kept, it should firstly be re-located within the building, such as moving a wall internally. If that is not possible, it should be investigated if there are materials to collect from other parts within the same company, otherwise, secondary materials can be looked for externally. Lastly, it should be the option to buy new (*respondent K*).

5.2. Demand for reuse

5.2.1. *Current circumstances*

Given how the general understanding of reuse differentiates between the *respondents*, it can be explained by the fact that reuse is a new concept within the construction industry and not yet a fully developed procedure. *Respondent D* started working with reuse in 2014, however *respondents A* and *B* had only worked with it the last 4-5 years. *Respondent E* mentions how the interest and knowledge of reuse has escalated when the new waste regulations got implemented in 2020 which included measures for reuse. Agreed by all *respondents* is that reuse is contextual and implemented differently in all projects they have been involved in. *Respondents D and E,* both situated at Sweco, have seen an increased interest among clients for reuse and explain how the demand has become so high that they do not have enough capacity to serve all clients.

Respondents A, B, and C as project consultants have seen reuse becoming more prominent and demanded by their clients. *Respondent C* tells of a refurbishment project where the client wanted to reuse as much as possible and how the consultants were put in charge to make it happen. The reason for this increasing interest among clients is argued to be dependent on a general conscience of the environmental impact of buildings according to *respondent A*, which also has been noticed in commercial properties by tenants according to *respondent D*. *Respondent J* describes the industry's sentiment as a societal development influenced by new regulations and the requirements from the client. *Respondent F* argued similarly and described how the development's direction is dictated by the client's demands as long as it is within the developer's ability. This explains the varying extent of reuse and how it has been implemented and is evidently project dependent. *Respondent K* explains the consequence of how project dependency makes companies use sustainability measures in projects where it is suitable:

"You make these flagship projects that look good in the media, but it does not have a bigger value. The reason why reuse in construction often goes over budget is that people try too much." - *Respondent K*

Reuse is according to *respondent K* a process that is occasionally used to promote the company rather than being the most resource efficient alternative. This leads to two general scenarios, firstly, projects that implement the maximum amount of reuse possible and secondly, projects where reuse is not considered at all. Something that *respondent J* also means risks reuse being misused and highlights the importance of distinguishing between resource saving and climate impact.

"...if we discuss reuse, somewhere, it is always resource saving when it comes to materials, but it is not certain that it is particularly significant in reducing the climate impact, not necessarily that the two aspects are automatically connected." - *Respondent J*

Respondent J continues by stating that it could become an issue if the current trend of sustainable construction only focuses on the reuse aspect of circularity. This might risk that other crucial circular aspects are forgotten, such as waste management. *Respondent D* associates project reports that describe reuse when it did not have a climate benefit as "greenwashing". *Respondent G* says that one needs to look at the big picture, to see what actually leads to climate benefits without affecting the quality of the building. Likewise, *respondents J* and *K* believe that reuse only should be applicable where the climate impact becomes lower than if it were produced new. They similarly reject the idea of using reuse on a detailed level such as individual products, instead, only utilising it in a broader sense with entire components. On the other hand, *respondent E and I* think that interior details and fixed parts such as wall sockets have potential for being reused. Additionally *respondent E* argues it is better to start small scale on all projects, even if the climate benefits are low and from there expand the degree of reuse. *Respondent F* agrees that reuse at the current state is more applicable for products rather than building materials. Even if reuse of expensive materials that hold a high degree of carbon dioxide such as metal are good for statistics, they are seen as more complicated to reuse, making products the more relevant option to reuse for the consultant's client (*respondent F*).

Apart from what materials that should be reused, there are also different views on which types of projects reuse should be implemented. *Respondent J* believes there is no need to maximise reuse in projects and that it is only relevant to reuse materials and products for refurbishments:

"The industry talks about implementing large-scale reuse and I hope this doesn't apply to new production, because it would mean that we would have to increase our

demolition rate to have material to accommodate all new production." - Respondent J

Other *respondents* view the potential of reuse in new construction differently. *Respondent A* believes that some sort of new production will always be needed since products and materials only can be used again to a certain extent. *Respondents F* and *K* think that reuse is possible to implement in both refurbishment and new production but believe that the market is not there yet in order to make it work on a large scale. Lastly, *respondents E* and *D* fully believe in implementing reuse in new production and this is something that will increase when the circular economy becomes more established in a few years.

There are other aspects brought up by the *respondents* that affect the applicability of reuse. *Respondent A, C, D,* and *K* explain how implementation of reuse in projects depends on the context of the building. For example, if the current building is filled with rooms, it is unnecessary to remake it for a tenant that wants an office with open landscape. It is in this sense more important to keep as much of the existing interior as possible before reconstructing the building. It is therefore argued by *respondent D* important to evaluate the characteristics of the building before any decisions are made and be flexible in finding a function for that specific building that actually works from its given conditions.

5.2.2. *Potentials*

Given the varying perspectives and understanding of reuse presented by the *respondents*, there is a consensus of the economical and climate potential reuse holds. There are several synergies with reuse mentioned if implemented correctly and purposefully. For example, *respondent A* argues reuse holds socio-economic benefits, as local maintenance of materials and products can replace the contemporary issue of outsourced production and overconsumption. It could also allow for the creation of new businesses within demolition, construction and within distribution and storage of reusable materials. *Respondent A* continues by discussing how such business could be beneficial for property owners as they would get paid to have someone come and retrieve excess material or material saved from construction. *Respondent E* brings up how the work with reuse is beneficial for the social aspect of sustainability: The method of implementing reuse in construction includes thorough inventories and guidelines for how materials and products should be disassembled. With a more structured process in demolition and construction, the safety at construction sites automatically increases. Additionally, *respondent E* sees how reuse has potential within other fields.

"Reuse is interesting to work with because it is the only subject within sustainability that increases security, reduces corruption, makes projects more profitable, you work with environmental benefits, we work towards being climate neutral. So it is the only

subject that combines everything and where there are effects in almost all 17 agenda 2030 goals." - *Respondent E*

All *respondents* agree that the economic aspect and benefit is what is going to continue to steer sustainable development in the construction industry, reuse included. This is argued by *respondent A, B, C, D* and *E*. For instance, *respondent D* showcased a project where the implementation of adaptive reuse led to both monetary benefits and climate saving. This was an old industrial building transformed into a hotel, an adaptive reuse project managed by Sweco which had the aim of persevering as much as possible of the original structure and feeling. This included saving concrete frames, reusing glass sections, doors, windows and installations, the project saved 120 million SEK in material costs. In another of Sweco's projects, a total of 14 000 individual products and materials were reused in a refurbishment project, which saved 500 000 SEK in material costs and 51,3 tonnes CO_2 equivalents. The projects are argued by the *respondents A, C, D* and *E* to be examples of how reuse can be conducted in projects. The savings are presented in reports for marketing purposes by the consultancy firm to showcase how their clients can work with sustainability. Besides the savings achieved during the transformation and refurbishment of buildings, *respondent A* and *D* both consider how fewer new constructions will be needed in the future since the life cycle of the current building stock will be increased instead. *Respondent J* further explains how the view and practice of demolishing buildings is changing and will become shameful in favour of disassembling or renovating projects.

An example of a potential tool within construction mentioned by *respondents D* and *E* are digital twins, which are 3D models of buildings that showcase their component data regarding environmental impact and also permits for an inventory of all materials in the building. Similar to this is the example of a management database for materials within buildings through the use of QR-codes which would allow for categorization and a systematic approach to measure materials and evaluate their quality (*respondent K*). Additionally, most of the *respondents* talk in some form of a digital marketplace which would allow for the purchase and selling of secondary materials. While such sites currently exist, their services are not fully incorporated into the standardised process but instead utilised on a project basis. *Respondent E* sees the opportunity for hardware stores to sell secondary materials as an alternative, this could potentially alleviate the issues regarding quality assurance and increase the supply of secondary materials on the market.

5.2.3. *Challenges*

All *respondents* see a potential with reuse to a certain degree, but for it to reach its full potential there are some challenges to overcome concerning implementation and overall vision. As previously mentioned, some of the *respondents* saw possibilities with how money is steering the future of reuse, where a shift to a circular economy will be a big part of the transition. Others see

how money can be a challenge for the future of reuse in the construction industry, where other incentives are needed: *Respondents A, B, I* and *J* mention the construction industry's slow pace of adapting change when it comes to incorporating new trends and innovation. They state the reason being that actors can have a difficult time seeing the direct economic benefits from experimenting and implementing new methods, making it difficult to incentivise. *Respondent F* thinks, when asked if any particular actors are difficult to collaborate with, contractors are brought up as usually having difficulties on trying new methods. On the other hand, *respondent J* mentions how the development within the industry is heavily dependent on the actions of property owners, as they dictate the market and decide what is going to be developed and how. Additionally, *respondent G* tells from their experience as a consultant, how their clients sometimes only do as required by law.

One of the most common challenges brought up by the *respondents* is how there is no established procedure, which hinders reuse to be established and utilised on a large scale and to its full potential. Commonly brought up aspects is how the reuse process includes additional labour, knowledge and tools. For example, *respondent F* describes how a careful deconstruction takes longer time for the contractor than a normal demolition and that it could give the impression that it would become more expensive even though the secondary materials saved would grant financial benefits. Additionally, *respondent A* has experienced how additional labour is required in handling the materials that are to be reused. *Respondent A* further believes that the whole value chain needs to work together with logistics and lifetime of materials, as well as inventories and handling of products. *Respondents C* and *H* note how they often do not have adequate time to take inventory in the initial stages of projects, and therefore miss out on many reusable materials.

Respondent K explains the challenges as being the low demand and supply for secondary materials. This makes it difficult to find external secondary materials from marketplaces or from other actors, where one must rely on contacts or internal stockpiles to utilise reuse. Consequently, the total costs for reusing materials in projects becomes higher than buying newly produced materials (e.g., *respondent A, F, L*). *Respondent E* addresses how it is difficult to work with reuse as an independent actor and that it requires coordination between actors to facilitate external trading of surplus materials. For projects where materials and products have been reused, *respondents A, B, C, D, I* and *K* explain how most of the materials are mainly distributed internally. The shared reasoning being due to a lack of coordination and challenges in distributing and storing material when in transition. All *respondents* mention the difficulties in the logistics of storing the secondary material and are lifting it as one of the key challenges with implementing reuse on a large scale. *Respondent E* discusses the challenges of establishing a suitable network for the flow of secondary materials from one project to be matched with another project where it could be used. A new form of role that matches materials with projects and vice versa, described as a *reuse consultant*, is here argued as becoming more important as demand for reuse continues to rise. This will be a challenge

in itself, to properly utilise this role and make it prominent for the construction process (*respondent E*).

Another commonly mentioned aspect related to the difficulty of implementing reuse is in how to ensure the quality of the materials being reused, particularly when buying secondary material. Several aspects are discussed, *respondent F* believes this is due to the lack of essential information regarding buildings, their components and the materials used. An example is how there is no easily accessible source of information regarding which year buildings are constructed, where it would be easier to match reusable materials between buildings constructed within similar timelines, since they most likely are utilised with similar materials and building techniques (*respondent D*). Additionally, because of how construction standards and architectural trends have changed throughout time, it has become especially hard to find material information about older buildings *(respondent F).* Consequently, due to the poor documentation of the current condition of secondary materials, *respondent G* points out the high risk for hazardous substances in materials. Similarly *respondent A* and *J* mentions the difficulty in controlling and guaranteeing the materials hygiene, an example being how porcelain has a life cycle of 200 years, but it is difficult to find a demand for reuse of toilets because there is a social stigma. *Respondent L* brings up a similar argument by how people do not want to sleep in a reused bed but have no problem with staying at hotels.

Respondents H, D, B and *K* mention the difficulty of ensuring the life cycle of secondary materials compared to new materials. Consequently, it becomes a matter of accountability. New materials commonly have a warranty of two years, at the same time, the constructor usually has a five-year warranty on their execution. When reused materials are implemented in the project, *respondent I* cannot see how the warranty can be ensured in the same way as it is with new materials. Meanwhile *respondent E* does not see why the quality of secondary materials is seen as a challenge and describes it as a general inexperience and lack of knowledge among actors, where the process of assuring the quality of a used product is considered being the same as for a new product. The lack of knowledge is also justified as a major challenge among other *respondents*.

Even if there would be an established market for reuse, there is also a risk that the trading of materials would not be evenly distributed geographically according to *respondent F*. Reducing the climate impact within the construction industry would therefore be varying between different sized markets. Additionally, *respondent D* mentions how municipalities and regions with more money have the ability to set up ambitious sustainability goals. Smaller regions with less money could therefore fall behind, where the incentives for companies in these regions could be smaller.

5.3. Improvement areas

What can be seen is that there is a varying perception between actors of what reuse is and regarding the willingness to conduct new methods in projects. There is a general understanding that the implementation of reuse only can be established on a large scale if the economic incentives are good enough. For example, *respondent K* believes how taxing new materials would be a possible solution to change the demand for reuse in construction. According to *respondent C*, if more requirements regarding implementation procedures are set for the entrepreneur, reuse would be easier to initiate. *Respondent E* sees how new regulations and the inclusion of circular construction in the planning and building act have escalated the demand for reuse on the market. *Respondent D* explains how Sweco have set internal goals to reduce the company's carbon dioxide emissions by 50 percent by 2030, something that has pushed the encouragement to find new ways to work. *Respondent J* mentions how policies in construction in favour of the climate is an emerging aspect that is going to have much more impact in the future. For example, the climate declaration set by the Swedish government is mentioned as a new requirement initiated in 2022, where the climate impact for the constructions of new buildings needs to be registered. This is considered to favour the demand for climate friendly buildings.

5.3.1. *External cooperation and coordination*

Besides policies and new requirements, in order to establish reuse on a large scale, initiatives are required from the private sector as well. *Respondents A, E, F, G, J,* and *L* mention how it is essential to establish a network between actors to facilitate reuse on a large scale. There are two types of networks mentioned, either through digital platforms, where businesses can trade materials and products, or physical networks between individuals externally or within companies. *Respondents A, C, E, F, H,* and *L* see great potential in digital networking through platforms where materials can be traded, and buildings can be registered. At the moment, many companies use internal platforms and communication for inventory and distribution to facilitate reuse (*respondent E*). There exist digital marketplaces for all businesses to trade secondary materials on, such as CCbuild and Palats. These are however considered complicated to navigate (*respondents C* and *G*), and do not have sufficient volume of materials available to satisfy the market (e.g., *respondent K*). Additionally, *respondent J* mentions how digital platforms for trading secondary materials have been around since 1996, continuing that the issue is not the lack of platforms but rather the low demand.

Respondents F and *L* are more optimistic about the future of digital platforms. *Respondent F* sees how the development is much faster now, and *respondent L* argues how there is a need to be more flexible when trading reused materials as the market is still relatively small. Both argue how individuals and businesses should be less specific when looking for products online, instead of

searching for specific characteristics and designs, function should be the main focus. Regardless, it is necessary to improve existing databases to make them user friendly, flexible and increase the number of materials (e.g., r*espondent C* and *H*). *Respondent A* sees industry-wide economic benefit if there was a singular database which was user friendly and made products traceable, where one also could buy and sell materials to other companies if they cannot be used internally.

Access to a substantial network of contacts within the industry is argued as important as the development of digital platforms. *Respondent J* has had instances where material was easier gathered from business contacts rather than from websites or resellers. The *Respondent* additionally sees how cooperation between companies should focus on finding the best solutions that all actors in the value chain can benefit from, by sharing ideas and keeping it non-competitive. A large network of contacts could also solve the problem of the varying market sizes between bigger cities and smaller towns. Here, cooperation between companies would facilitate smaller clusters of businesses in areas where the market for reuse is much smaller according to *respondent L*. Additionally, *respondent E* also mentions how adequate communication among actors constitutes a possibility for consultancy firms to take a coordinating role by positioning themselves with the help of a reuse coordinator.

To further facilitate coordination and figuring out the most suited solutions for reuse, it is overall considered necessary to be involved early and plan for reuse. For example, *respondent F* mentions how there usually is a lack of information about the characteristics, materials and products in the buildings, which makes reuse complicated in the later stages of projects. It is therefore needed to make thorough inventories of buildings before any other executions are made to know what needs to be reused. This also enhances the possibility of matching the materials with the right buyer in cases when the material cannot be reused internally (*respondent E*). *Respondent D* and *K* sees how future buildings are going to be designed for more flexible use, meaning that the building's premises will be more adjustable, and the materials will be easy to disassemble. To enable such designs, it is also considered necessary to be a part of the project in the early stages.

5.3.2. *Internal communication*

What is seen among the *respondents* is how there is a need for better external cooperation between actors in the value chain to enable reuse. Looking from Sweco's perspective, it is also seen as essential to have great communication internally (*respondent E*). The company's overarching values have always had an aim to deliver sustainable solutions for their clients (e.g. *Respondents A, C, D, E,* and *F*, all employed at Sweco). According to *respondent E*, there is a wide sustainability mindset in everything they do, which is not limited to a certain boss or consultant. More specifically, in Autumn 2022, the company defined how each department should work with reuse, something that has enabled Sweco to work together as one unit instead of each department and

team working individually. This has, according to *respondent F,* enabled an increasing awareness of the possibilities with reuse internally and to their clients. At the same time, *respondent D* mentions how the company has started with sustainability coaches in the initiation of new projects to guide the project managers in implementing sustainability solutions. There are additionally a variety of optional forums and mandatory training courses for the employees at Sweco to discuss questions regarding sustainability (*respondent B* and *D*).

On the other hand, *respondent F* and *G* mentions how most information about new methods are gathered in personal contexts, such as between colleagues, social media or from news sites. Additionally, the cooperation between the company's departments is seen to mainly be done on a project-basis according to *respondent D*. For example, *respondent B* has not worked with the company's sustainability experts before but could see it as a possibility for future projects. *Respondent C* sees how Sweco could be better at informing the employees what expertise the company has to offer to its clients, by learning from each other and selling sustainability better.

5.3.3. *Ability for consultants to influence*

The role of Sweco as a consultancy company regarding the implementation of reuse is perceived by the respondents as being of influential nature. *Respondent B* appreciate Sweco's role in marketing their work with sustainability between colleagues and through clients. It is a shared view among the interviewed Sweco employees that they can only influence and push for reuse in projects where the client is interested. On the other hand, if it was possible to come in earlier in the process, their influence as consultants would have a greater impact according to *respondent A, B, C, D* and *E,* especially in cases where the client has no previous experience or expertise in-house.

The external *respondents* have a varying view on the role of consultants in general regarding reuse and technical support. *Respondent K* believes that as much as possible should be done internally in the company and that they run a risk, when involving external actors, that it might impact the overall consistency of the company's work and vision. *Respondent L* also agrees that most of the work should be made in-house but appreciates the need for professional competence from consultants for specific technical fields. This aspect is seen as extra important when working with reuse since the degree and ways of implementing such measures is heavily project dependent (*respondent L*). Lastly, *respondent J* sees how the numbers presented for marketing reuse and other sustainability methods made by big consultancy firms can be misleading and should be interpreted carefully. The way companies market reuse can consequently be misleading, where the reduction of the embodied environmental impacts from the whole lifecycle of projects could be more transparent to the clients according to *respondent L*.

6. Analysis and Discussion

This chapter presents the analysis of the results based on the identified themes. Firstly, the varying views of circular construction and reuse are presented and discussed. Secondly, the identified challenges with implementation of reuse are untangled. Thirdly, the abilities for consultants to influence the construction industry are discussed, as well as specific recommendations for Sweco to introduce in favour of reducing the embodied environmental impacts of buildings.

6.1. Perception of circular construction

6.1.1. *The emergence of reuse*

When interpreting the *respondents'* answers on circular construction, there seems to be a general consensus that the sustainability aspect has become a central part in the construction industry and is considered in all projects brought up by the *respondents* to certain degrees, similarly portrayed by Zuo et al. (2012). It can be explained by what Chen & Chang (2013) discuss as an overall increased public awareness of the environmental issues among stakeholders, which consequently might lead to companies using certain terms for marketing purposes. As seen by Korhonen et al. (2018) the concept of CE is primarily developed by practitioners and policymakers and less by scientific researchers, which could explain the increased awareness of CE among stakeholders. It is therefore important to highlight the broad understanding of the concept, where for instance *Respondents I, J, and K* sees it as irrelevant to discuss concepts such as sustainability and circularity on a project level. Instead, they highlight the importance of being aware of the embodied climate impact connected to different stages of the building's life cycle, similarly discussed by Moncaster & Symons (2013) and Hasik et al. (2019). In other words, the main focus should be on making the climate impact of the projects as low as possible instead of focusing on terms. These opinions are in line with the aspect brought up by Corvellec et al. (2021) and Kirchherr et al. (2017) meaning that the variety of definitions for CE makes it unclear for initiators to implement the concept in practice.

Consequently, one cannot only consider the environmental performance of the building, but should also consider the embodied environmental impacts, as argued by Nussholz (2019). There is an agreement among the *respondents* that as much of the current buildings, materials and products should be preserved and refurbished, as well as to avoid any unnecessary new construction when possible. These aspects are similar to what is described by Ellen Macaurthur foundation (2021) and Wahlström et al. (2021) as needed in order to enable a shift towards a circular economy, but also by Remøy et al. (2019) as the idea of moving away from the linear "take-make-waste" towards a circular model. Even though there seems to be a common view among the *respondents* that there is an ongoing shift in the construction industry in favour of reducing the environmental impact, it is still in an early stage of development. Aspects of incorporating reuse in projects can be

confirmed by all *respondents* as an emerging trend in the construction industry. It is since 2018 that it has been seriously discussed and taken into consideration, which can be seen in the Swedish adoption of waste management as well as in the EU: s waste hierarchy (European commission, 2023), in addition, it is argued by Anund Vogel (2022) for being a new construction practice in the industry.

With this in mind, there is a risk that projects incorporate reuse without being aware of how it is best implemented or how and in what ways it can be a tool to reduce the climate impact of a project. This becomes relevant as businesses sometimes want a "sustainability stamp" without knowing what it is about (*respondent F*). This could consequently be problematised as a form of greenwashing as described by de Freitas Netto et al. (2020). To clarify, as mentioned by *respondent E* and explained further by Ellen Macarthur foundation (2021), reuse is just one of several ways of incorporating circular measures in construction. As further argued by *respondent J*, other aspects are considered as important as reuse and risks being sidelined in favour of reuse that is currently dominating the conversations. The way companies implement reuse in their projects could therefore be based on alternative reasons, where it is about marketing the project as "green" rather than implementing the most efficient measures (Nyilasy et al., 2014). Hence, businesses create flagship projects that look good in the media (*respondent K*) which in the end might not be certain to significantly reduce the climate impact of the building (*respondent J*). Similarly, when research about circular construction is mostly hypothetical and less on how it can and has been implemented in practice, there is a possibility that circular economy stays a concept that is not applicable in practice (Leipold et al., 2023; Völker et al., 2020).

Respondent J mentions how the focus on terms and concepts can be misleading when it comes to implementation, where it is more about saying what to do than actually doing it. Therefore, it becomes important to look at the big picture and assess to what degree reuse leads to reducing the climate impact without affecting the quality of the building (*respondent G*). Similar argument is brought up by Vadenbo et al. (2017) that sees how the potential of reuse might get undermined if the process of utilising secondary materials is too complicated. Therefore, *respondent D* and de Freitas Netto et al. (2020) argue how it becomes crucial to assess the potential benefit of reuse in order to avoid greenwashing.

6.1.2. *Scale of reuse*

Commonly brought up by the *respondents* and in the literature is the low degree of reuse that is currently implemented in construction projects. As a consequence, certain actors see no point in implementing new measures and would rather wait until the market and methods are more mature. The role of the *respondents* could here be helpful to explain the varying views. It is for example brought up by *Respondent I* who works as a developer for a government-controlled business, by *respondent J*, working as a research- and innovation coordinator at a construction company, and

respondent K working as a developer at a publicly owned real estate company. On the other side, certain *respondents* are more optimistic to implement reuse before the market is fully established. This is for example seen by *respondent F*, working as a consultant for Sweco that argues for how reuse at the moment is most applicable for interior and products and not for building materials. Additionally, *respondents E and L*, working as a sustainability specialist at Sweco and head of sustainability at Castellum respectively, describe it as a process of raising the minimum threshold of what can be reused and exploring ways to do it. In other words, it is more practical to utilise reuse small-scale in each project rather than maximising its implementation in a few projects. What can be seen is that the *respondents* who are more positive to implement reuse when possible either have a role as consultant or sustainability experts, while the less optimistic opinions are from *respondents I, J,* and *K,* who are either clients or working for a construction company. This can partially be explained by the current increased time and planning for implementing reuse.

When examining reuse as an alternative method in construction, different perspectives are prominent when looking at the *respondents'* views on if reuse should be incorporated in new production or only in refurbishment projects. For instance, *respondent J* was clear that implementing reuse on a large scale in projects is not relevant for any new production since this means that more needs to be demolished. Instead, it is argued that the main focus should be on keeping things where they are and not complicate the process. At the same time, other *respondents* (e.g., *F, K, E and D*) see how a large-scale reuse will be in both refurbishment and new production, which is similar with the visions seen for the circular economy in the literature (e.g. Ellen Macarthur Foundation, 2021; Almeida & Solas, 2016; Wahlström et al., 2021).

This division can be compared to the overarching views on CE as a concept. The critique brought up in the literature shows no evidence that economic growth can become decoupled from resource use on a global scale (Hickel & Kallis, 2019; Vaden et al., 2020), whereas Völker et al. (2020) compares CE with "sustainable growth" and "green growth". It is at the same time clear that the less optimistic *respondents* see how reuse becomes one of these methods that might be misused by companies, where it is considered more important to implement reuse that works for all construction projects in whichever context instead of reusing individual products. In other words, even if all *respondents* see a future with reuse, it is not commonly argued that a circular economy is going to fully replace the current construction practices.

The different views on how the emergence and scale of reuse should be dealt with could be explained by how businesses in a linear economy are usually working within their own frameworks and policies (Gupta et al., 2019). This can be supported by the fact that the interviewed consultants see how the implementation of sustainability measures is project dependent (e.g., *respondent A, C, and D*).Gupta et al. (2019) explains it as dependent on either goal conflicts or perception conflicts. The goal conflict is referring to how businesses work with different sustainability goals, which will affect what degree measures such as reuse are incorporated. The perception conflict

means there are different understandings among stakeholders as well as among the *respondents* what sustainability is and how it should be incorporated into the construction industry. In this sense, there seems to be no clear structure on who has the responsibility for implementing reuse in projects since the *respondents* are working within their own views and guidelines. This could also be explained by what Hwang & Ng (2013) mention, how the focus on sustainability in projects have broadened the role of project management. In other words, when the demand for reuse is increasing, the requirements also increase in projects. The project manager could in this sense be seen as having a widened responsibility in conducting the projects after what is required.

6.2. Untangling the challenges with reuse

Based on the *respondents'* answers, there is a general view that reuse has great potential to become more prominent within the construction industry, but to a varying extent. At the same time, it is commonly seen how there are a number of challenges limiting the potential to implement reuse. The most commonly brought up aspect is how the lack of standardisation and non-established systems for coordination makes the economic incentives low. While there are synergies related to reuse as a measure for circular construction such as benefiting the local economy (*respondent A*) and contributing to social sustainability (*respondent E*), the integration to the industry is seen as too slow. The construction industry is viewed as being traditional and slow to adapt innovations according to *respondent A, B, I and J,* this is similarly argued by Garca (2005). The reasoning behind this can be explained by the fact that actors cannot see the direct economic benefits of implementing new methods. It is thus a challenge to maximise the value of secondary materials (Kraaijenhagen et al., 2016) so the benefits of reuse become evident for all actors in the value chain. Furthermore, what is seen in the results is how property owners and entrepreneurs are the ones that have the most to say about what is going to be done. They are in this sense the ones who are steering the degree of reuse implemented.

What can be concluded is that the market is fragmented, the decisions on which measures to include are context-based and dependent on individual projects. The current state of the construction industry can therefore be characterised by how actors positioning themselves from an overarching perspective see the potential of reuse, while the actors working on the projects, such as entrepreneurs, do what is economically beneficial for their company. The envisioned synergies of reuse are thus not apparent for all actors. It therefore becomes a challenge to make the benefits of reuse prominent for all actors in the value chain. To enable such a widened view among stakeholders, there are two identified underlying challenges that need to be tackled: developing the market for reuse and changing from a linear to a circular mindset in construction.

6.2.1. *Developing the reuse market*

The challenge of establishing a comprehensive market for secondary materials is brought up in the literature (e.g., Nußholz et al., 2019), as are the synergies regarding all stages in the building's life cycle when the market for circularity is established (Dong et al., 2021; Souza, 2013). What measures to incorporate for establishing a market are less prominently explained. However, it can be stated from the empirical evidence that the project-based practice is currently steering the distribution of secondary materials. One eventual problem with this might be that certain aspects only are brought up when it is relevant to the client. For example, if the initiation of reuse is not brought up, it would not be taken into consideration throughout the project.

In cases when reuse is implemented, most materials are distributed internally within a company's stock. Consequently, to what scale reuse can be implemented, is heavily dependent on the size of the project and the company. In other words, when the *respondents* have implemented reuse in their projects, it has mostly been within refurbishments, where products and materials are collected from the renovated building or within the company's own inventory, and less from what is available on the external market. As a result, the *respondents* mention obstacles such as a low supply of high-quality secondary materials in large enough quantities. Too much time is therefore considered required to locate the secondary materials, which additionally leads to high labour costs when implemented in projects. The implementation of reuse can therefore become dependent on how big the company is. Smaller companies with less variety of competence and fewer internally available materials could thus be seen as more affected by the low supply of secondary materials on the market. At the same time, this explains the problematised divide between large cities and smaller towns where the market for secondary materials is smaller. Even if a large actor might have the competence and experience, reuse would not necessarily be economically feasible or practical on a large scale without cooperation with other actors as argued by the *respondents*. Therefore, it becomes crucial to find ways to collectively work with reuse, in line with what is brought up by Antikainen & Valkokari (2016). Lewandowski (2016) brings up the aspect of finding a mutual sense of responsibility between stakeholders to make circular economy practises feasible.

There are *respondents* that mention the importance of economic incentives driven by policies, such as subsidising secondary materials to make reuse economically beneficial for the contractors. From this perspective, reuse would be economically beneficial for a wider group of actors, not just the companies with large networks and high turnover, something that also is arguably crucial for a successful transition into a circular economic system (Kircher et al., 2017). Equally important, the *respondents* value initiatives driven by companies that set new precedent or help accelerate large scale reuse. Similarly to Joensuu et al. (2020) it is seen as important to incorporate a balance between top-down and bottom-up coordination to enable a large-scale market for reuse. To enable

this coordination, there is an overall agreement among the *respondents* that digital platforms and physical networks for reuse will be important for the future supply and acquisition of secondary materials. It is not only seen as a convenient way to establish trade between actors, but also enables future quality assurance and tracking of products and materials.

Developing a large-scale market for reuse is evidently crucial to enable a wide range of actors to implement reuse. There is also the aspect of equalising the difference between larger and more dispersed markets. Creating a standardised procedure through improved digital platforms can be seen as beneficial to larger markets at first hand. Although, if there would be a user-friendly platform, it would not necessarily increase the supply and demand for secondary materials to smaller markets in less dense urban areas. Subsidising secondary materials is one solution to increase demand and make reuse economically feasible for smaller markets. But there is still the aspect of logistics, as long transport routes between markets could make the climate benefits lower compared to using virgin materials, as argued by Vadenbo et al. (2017). A potential alternative to the logistical aspect is the establishment of a large social network. As argued by *respondent L*, better cooperation between companies and individuals could facilitate smaller clusters to trade secondary materials. This could potentially reduce the need for long transports and widen the reuse market. It is thus evident that it is important to combine different solutions for making reuse universally adoptable.

Most *respondents* agree that the current digital platforms do not meet the requirements for large scale reuse. Instead, many actors use their own internal platforms. At the same time, *respondent J* mentions how digital platforms for trading secondary materials have been around since 1996 and does not agree that they are the missing link to fully realise reuse. Instead, it is argued that most of the cooperation can be done through physical networks. This view is more similar to the idea that an external market for reuse should not be the main focus. The argument is that a cooperation should rather focus on finding the best solutions for all actors in the value chain, by sharing ideas between businesses and keeping it non-competitive. As argued by Zhang et al. (2013), there is a need to constantly share and stay updated on knowledge among stakeholders in the industry. In this way, reuse can be evaluated as a method of circularity, where the main focus instead is on reducing the climate impact of buildings, with the long-term goal of making it profitable.

6.2.2. *Changing the mindset*

This leads into the second challenge that needs to be evaluated, to change how the life cycle of buildings are perceived. What is described by Wahlström et al. (2021) is that there are new visions of how the construction industry should be structured. Similarly, a few of the *respondents* brought up the importance of reducing demolishment of buildings, to instead understand the value of keeping and preserving buildings as they are and repurposing them when needed. Since there is a

general understanding that reducing the climate impact of buildings is the main goal for reusing materials, it is therefore argued important by some *respondents* to not focus on constructing new buildings. This is for example brought up by *respondent K* who argues that demolition in the future will become more shameful and seen as an unsustainable practice.

There are some additional factors brought up connected to this challenge. One aspect being how the consumption pattern in a linear economy is characterised by quickly switching trends in the industry. For instance, something that is seen as aesthetically appealing and modern, will become unmodern within a few years. Similarly, architectural trends change, making the characteristics of buildings vary depending on building year. Another brought up aspect is the overall belief that newly produced is better than reused. This is partly seen for specific furniture, for example, *respondent A* mentions the dilemma of how people have no problem staying at hotels in sheets used hundreds of times but could not buy a reused bed even if it would be cheaper and easier. The same patterns can in part be seen within the construction industry. One aspect regularly brought up is quality assurance and guarantees for secondary materials, several of the *respondents* believe that the warranty of reused materials in projects is a big limitation for incorporating reuse in their projects. The European Environment Agency (2020) also brings up how the lack of high-quality materials from demolition as well as construction practices in the past explains the low supply of secondary materials able to reuse. An issue which will be less prominent in the future as building materials are predicted to be of a higher standard (ibid). This means that quality standards will be easier to uphold, and reuse can become more accessible for all types of construction projects.

A solution to ensure the quality of materials in buildings is to initiate reuse early in construction projects, all *respondents* value the need to come in early in the project. The same is argued by Esa et al. (2017), who points out the need to consider waste management early in the process, as well as by Kovacic & Zoller (2015), who argue for how the emissions from the building are dictated in the planning phase. Liu et al. (2021) emphasises how a thorough planning phase can erase most of the excessive emissions from the whole construction process. Additionally, the results further clarify this by showing how better coordination in the initiating phase of the project could alleviate the demand for new construction. For instance, all *respondents* argue for the requirement to get more time in the early stages to be able to do proper inventories of what materials can be saved and what available secondary materials can be incorporated. Better inventories would also enable a knowledge of what materials and products that are of decent quality in buildings, which will be relevant when facilitating eventual disassembling. There is also the aspect of designing buildings for flexible use of space and for disassembling, which also is brought up by Wahlström et al. (2021). Linegård & von Olreich (2023) also propose how standardisation of design choices for buildings is a potential alternative to enable disassembling. The costs of spending much more time before execution is argued for becoming favourable later on in the project when less costs are needed for buying new.

In order to enable coordination of projects that benefit reuse, the aspect of informing the actors in the value chain is seen as valuable. For example, *respondent E* mentions that the main reason why actors are doubting the quality of secondary materials is because of a general lack of knowledge or experience, as also identified by Mahpour (2018) as the main barrier. In fact, quality checks of secondary materials can be done the same way as new materials, meaning that it can be documented based on the same premises as newly produced materials. In the same way, the challenge of distributing secondary materials between projects could be argued as a lack of knowledge, as also described by van den Berg (2020) as implicit knowledge, requiring the process to be easy to initiate. The solution is proposed that with great coordination and documentation of existing buildings, most of the materials and products being reused can be distributed directly between internal projects between the same client or through a larger external network.

The informative part of enabling reuse is as mentioned a matter of cooperation within the construction industry. The aim being to come up with collective solutions, and not develop competitive solutions (Antikainen & Valkokari, 2016). This could also be considered to be the reason why a decoupling of reduced climate impact and economic growth has not been established, partly because a market for circular construction has not yet been established. As part of this, it becomes important to look at the overall climate impact, rather than implement measures to the highest degree possible, as a way of marketing. On the other hand, marketing the projects can be seen as a factor that is keeping reuse topical, and thus continuing the trend. By making flagship projects that maximise certain sustainability measures such as reuse, it can showcase other actors how reuse can be beneficial, even if it might not be economically beneficial for that specific project. It rather could make other actors take inspiration from these projects and incorporate similar measures in their development projects, something that thereafter can be used as a selling point to the tenant. In this sense, by marketing reuse as a sustainable option, there is a possibility to slow down the linear trend of consuming new, to instead make used materials the “trendy” alternative. For example, Sweco uses their reports where reuse has been implemented to show their clients of its potential. The reports show how clients both can reduce their climate impact in CO_2 equivalents and how reuse can save money, something that can be argued for being the most valued aspect.

A part of the external cooperation can in this sense be the aspect of companies taking inspiration from each other's projects. On the other hand, all actors want to benefit from the process, there is a risk that the competition between companies is hindering external cooperation, where companies might hold certain information to stay competitive. An example can be seen with how most actors use internal digital platforms for distributing secondary materials instead of unionising on one. A part of changing the mindset in the industry therefore also requires actors to not use reuse as a competitive strategy, where actors instead should see the trading potential of distributing

secondary materials. While sharing practices between actors might be seen as counterproductive with a company's need to stay competitive, it is argued by *Respondent J* to potentially become beneficial for all actors in the value chain. Similarly, Antikainen & Valkokari (2016) argues how circular construction would not be financially or environmentally beneficial if implemented individually, hence suggesting how collective solutions are needed.

6.2.3. *Consultants' ability to influence*

The demand for consultants in construction projects is something that is less covered in literature. What becomes clear from the results is that the incorporation of measures to reduce the climate impact of buildings have undeniably made an impact on the role of consultants and will influence how projects are structured in the future. Hwang & Ng (2013) mentions how project management in general has changed when new techniques are introduced on the market in favour of sustainability.

As seen, to facilitate circular construction measures, more focus needs to be put on the early stages of projects, such as doing inventories, and designing for more flexible use. The consultants can thus have an important role in facilitating the initiation of reuse in projects. Additionally showcased is how the role of so-called reuse consultants will become more prominent, someone who has the responsibility of coordinating supply of materials and products between projects and clients. They could likewise be involved in the early stages of projects and take inventory of refurbishment and demolition projects. Therefore, the client does not need to care about material quality or storage for secondary materials as the consultant holds responsibility. Combined with other expertise Sweco offers would allow small companies to initiate reuse in projects even though they themselves lack internal knowledge. Similarly, it benefits geographical regions where supply for secondary materials is lower, as materials can be distributed by individuals familiar with the local market. Bigger companies can utilise a reuse consultant in the same way, where less resources need to be invested in coordinating secondary materials. This creates the possibility for reuse to be cost effective by hiring a consultant that has the network and expertise to be beneficial for the project, even though it is an upfront cost. If the convenience and economic benefits of hiring a reuse consultant is mediated to the client, there is a possibility that more actors would be open to initiate reuse in their projects.

What is prominent from the results is how big consultancy firms, such as Sweco, have a wide range of expertise connected to the built environment. One of the main challenges is to make use of this expertise where it is the most needed. As argued by Robinson et al. (2005), the internal knowledge in a company steers the competitiveness within the industry. It is important for the consultants to communicate with other actors in a way so that they are seen as an attractive alternative in cases where there are possibilities to influence the development in favour of the environmental impact

and resource saving. The knowledge is in this sense one of Sweco's biggest strengths, considering its size and wide range of expertise. It is in other words a matter of how to sell this knowledge, so it becomes relevant for the client to make use of it and at the same time, becomes environmentally beneficial. Reuse can in this sense be an opportunity for the company to expand their supply of services in the industry, where their wide range of knowledge makes them highly competitive within the field, similarly argued by Leliaert et al. (2003). This also requires fluid internal communication. What the results show is that the majority of the *respondents* working at Sweco still are relatively unaware of how to initiate reuse in the projects they are a part of, especially in cases where the property owner or contractor wants to do the least possible.

At the same time, Sweco has implemented measures to improve their internal communication, such as defining how each department should work with reuse. How this has influenced the company's performance is still early to say, but a few of the *respondents* see how the work with sustainability and reuse in particular could be improved. For example, *respondent D* mentions how the cooperation with other departments is not consistent and rather project dependent, *respondent C* sees how Sweco has much room for improvements on the sustainability field, and *respondent B* have not been using the expertise that the company has to offer but is something that could be considered in future projects. As a consequence of not knowing what abilities the consultancy company has to deliver to their clients, this could lead to cases such as explained by *respondent K*, where hiring external workforce can negatively impact the overall consistency of the company's work and visions.

In order to make consultants a relevant option in these cases, it is important to coordinate the expertise so that it is used where needed, similarly to what Nakamori (2020) and Sommerville & Craig (2006) describe as knowledge management. Hence, just maintaining the knowledge is not considered enough in order to compete with other actors (Davenport & Prusak, 1998). Big consultancy firms have the ability to provide specialised expertise in certain fields. This expertise is something that for instance *respondent L* means is the main reason for hiring Sweco's consultants. For the sake of reuse, the implementation is shown to be heavily dependent on several aspects such as on the project, the building, and the material. Here, it becomes relevant to use the broad expertise of consultancy firms to implement the right measures for a specific project. Since Sweco usually has the expertise in-house, it therefore becomes important to match their abilities with the right projects. *Respondents* mention how Sweco has courses available to keep the employers updated. These courses could have a bigger focus on informing how to make use of the expertise that the company already has internally, to provide the best solutions for their clients. If the matching of the right abilities to the right projects is done well, Sweco has the ability, with the help of their consultants, to influence the future development in favour of reducing the climate impact from the production of materials and generation of waste in the construction industry.

6.3. Recommendations to sweco

Based on the gathered insights from the results, analysis and discussion, Figure 3 gives concrete recommendations to consultants, more specifically to Sweco, regarding how to implement reuse in construction projects so it becomes beneficial for all actors in the process.

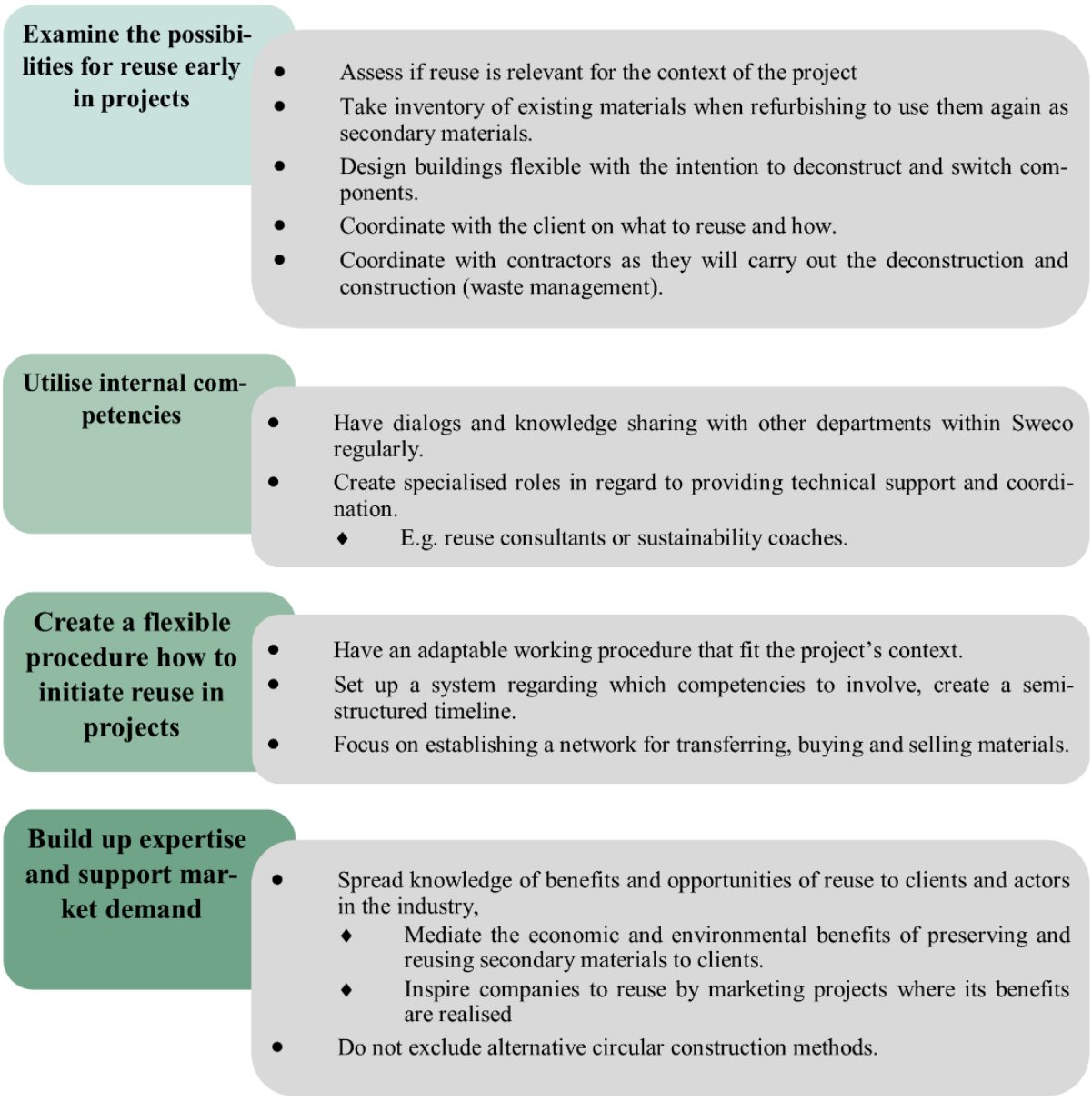

Figure 3: Recommendations to Sweco.

7. Conclusions

This thesis makes the emergence of reuse in the construction industry evident and that it will continue to garner relevance. The overall understanding of reuse is that it should be a method for better resource management and in the long-term, decrease the environmental impact of buildings and potentially contribute to a more sustainable industry. The approach on how to implement reuse differs between actors among different stages of the construction process. Some desire to initiate reuse in different scales in all construction projects to gain experience and raise the minimum threshold. Whereas others raise concerns of how the benefits of reuse could be misinterpreted and emphasise the importance of looking at the big picture regarding where reuse really is applicable, and thus, limiting reuse to cases where it is the most beneficial rather than focusing on incorporating it to all projects. This divide could be seen as a consequence of the fragmented nature of the industry and how companies work independently in a linear economy, where the implementation of reuse becomes project dependent. Consequently, the approach and benefits of reuse are not evident for all actors across the value chain.

In order to make the benefits of reuse evident for all actors in the construction process, two main challenges need to be prioritised based on what the respondents have said. *Firstly*, the market for reuse needs to further develop, partly through economic incentives, such as subsidising secondary materials in an attempt to make reuse economically beneficial for all parts. This should be combined with company driven initiatives such as digital platforms for trading secondary materials, tools to better facilitate inventories and coordinate logistics. Similarly, improved physical networks between actors would improve the reuse market through knowledge sharing. *Secondly,* the linear mindset in construction needs to change into a circular mindset. This includes avoiding new construction and demolitions in favour of repurposing buildings. Moreover, it is important to implement reuse in initial stages of projects to better coordinate between all actors. This allows the ripple effect of spreading knowledge and improving conditions for consecutive reuse projects, since it has the potential of showcasing the value in secondary materials. Additionally, it is important to showcase the results of reuse projects to inspire and push the boundaries of what is achievable.

Furthermore, the thesis makes it evident how consultants can influence the construction industry in favour of implementing reuse in projects. Including reuse consultants would allow for additional support in the early stages of projects to coordinate the logistics and management of secondary materials. This would ease pressure on other actors in the value chain, especially when the competences are limited in-house, and thus facilitate implementation of reuse in projects. The results show that the knowledge on how to implement reuse in different types of projects is prevalent among the consultants at Sweco but can be complicated to manage in order to maximise the benefits of reuse in projects. It is therefore necessary that all related positions at Sweco are

knowledgeable and undergo internal dialogues to capitalise on the different department's perspectives and experiences.

7.1. Reflection

After we have gotten familiar with the construction industry and the role of consultants by doing research for the thesis and talking to a variety of actors involved in the construction process, it feels safe to assume that reuse is going to be a standardised practice in the future. To what extent this will happen is however not as obvious. What becomes clear is that all actors do not agree that it is relevant to reuse all materials or implement reuse in all projects. For example, large-scale reuse in all new construction would mean that the pace of demolition would need to increase, which becomes contradictory to the main principle of the waste hierarchy, to prevent any type of waste generation. What is shown is how reuse has the potential to reduce the environmental impact from buildings, it is simultaneously prominent how this becomes dependent on a variety of aspects. There is further a risk that the effects of the ambitions to reduce building's environmental impact through reuse becomes insignificant if the chosen approach is not well thought out. As mentioned, there is a need for clearer frameworks to assess the effect of reuse in projects, in order to also minimise the risk of greenwashing. Even if flagship projects can be good to nudge the industry in the right direction, it does not mean that one should blindly trust the presented numbers. The heavily project dependent implementation of reuse makes procedures done in one project irrelevant in another.

Consultants have a good opportunity to position themselves well in the context based on the above formulated recommendations. There will be tougher guidelines and requirements for how to build in the future, it is therefore good if Sweco already is prepared for the changes, to stay competitive on the market. Since reuse still is in an early stage of development in the industry, it becomes very important to continuously stay updated on new practices of reuse, to not get caught up in the jungle of misleading sustainability terms, to instead focus on what actually makes an impact.

7.2. Further studies

The result of the thesis shows that consultants have the possibility to influence construction projects regarding the implementation of reuse. With the right measures, it is also shown to potentially reduce the embodied environmental impacts of materials and products in buildings. While the thesis provides an overarching picture of the possibilities and way forward for implementing reuse in projects, more is needed within the field of enabling practical implementation of such measures. With the implementation of reuse being project dependent, it is therefore relevant to further investigate to what scale materials and products can be reused in projects. But also, what type of materials and products that are relevant to reuse in order to make it economically beneficial, while also reducing the embodied environmental impacts compared to if reuse were not introduced. A more detailed framework is therefore needed to facilitate reuse on

project level, as a way to simplify the overarching ideas, to make the benefits evident and the measures practically feasible for the executors. Lastly, the need for a changed mindset requires actors to see the monetary value in preserving buildings and materials and through improved cooperation too. This requires the development of new economic models that take the costs and potential revenues of reuse into consideration.

References

Aguilar-Hernandez, G. A., Dias Rodrigues, J. F., Tukker, A. (2021). *Macro economic, social and environmental impacts of a circular economy up to 2050: A meta-analysis of prospective studies*. Journal of Cleaner Production, 278, 123421

Almeida, P. R., & Solas, M, Z. (2016). World Economic Forum. *Shaping the Future of Construction*. Available at: https://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report__.pdf

Andersen, N. M., Nöjd, K., Jirout, D. (2020). *Urban Insight, Going circular - a vision for urban transition.* Available at: Urban-Insight-report-Going-circular.pdf (swecogroup.com)

Andersson, J., Moberg, S., Gerhardsson, H., Loh Lindholm, C. (2021). Potential, effekter och erfarenheter från återbruk i bygg- och fastighetssektorn från den lokala samverkansarenan i Göteborgsregionen ”Återbruk Väst”. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:ivl:diva-3802

Antikainen, M., & Valkokari, K. (2016). A Framework for Sustainable Circular Business Model Innovation. *Technology Innovation Management Review*, *6*(7), 5–12. https://doi.org/10.22215/timreview1000

Anund Vogel, J. (2020). *Incentivising Innovation in the Swedish Construction Industry*. Stockholm. KTH Royal institute of Technology.

Boverket. (2019). *Standarder för LCA.* Available at: https://www.boverket.se/sv/byggande/hallbart-byggande-och-forvaltning/livscykelanalys/miljodata-och-lca-verktyg/standarder-for-lca/

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology. 3, 77 -101. Doi: 10.1191/1478088706qp063.

Brundtland Commission. (1987). *Our Common Future, From the Earth to One World: An Overview by the World Commission on Environment and Development*. United Nations. Available at: http://www.un-documents.net/our-common-future.pdf

Bryman, A. (2011). *Samhällsvetenskapliga metoder*. Malmö: Liber AB

Cabeza, L. F., Rincón, L., Vilariño, V., Pérez, G., Castell, A. (2014). Life cycle assessment (LCA) and life cycle energy analysis (LCEA) of buildings and the building sector: A review. *Renewable & Sustainable Energy Reviews*, *29*, 394–416. https://doi.org/10.1016/j.rser.2013.08.037

Carruth, A. & Grosse, E. (2022). Sweco. *Building the future through circular data. Available at:* https://www.sweco.co.uk/wp-content/uploads/sites/19/2022/05/Report-Building-the-future_Booklet-1.pdf

Chen, Y., & Chang, C. (2012). Enhance green purchase intentions: The roles of green perceived value, green perceived risk, and green trust. *Management Decision*, *50*(3), 502–520. https://doi.org/10.1108/00251741211216250

Convention on Biological Diversity. (2020). *Global Biodiversity Outlook 5*. Montreal. Available at: https://www.cbd.int/gbo5

Corvellec, H., Stowell, A. F., Johansson, N. (2022). Critiques of the circular economy. *Journal of Industrial Ecology*, *26*(2), 421–432. https://doi.org/10.1111/jiec.13187

Davenport, T. H., & Prusak, L. (2000). *Working knowledge : how organizations manage what they know*. Boston, Mass: Harvard Business School.

David, M. & Sutton, C.D. (2016). *Samhällsvetenskaplig metod*. (1. uppl.) Lund: Studentlitteratur.

de Freitas Netto, S. V., Sobral, M. F. F., Ribeiro, A. R. B., Soares, G. R. da L. (2020). *Concepts and forms of greenwashing: a systematic review*. Environmental Sciences Europe, 32(1). https://doi.org/10.1186/s12302-020-0300-3

Denscombe, M., & Larson, P. (2018). *Forskningshandboken : för småskaliga forskningsprojekt inom samhällsvetenskaperna* (Fjärde upplagan). Lund: Studentlitteratur.

Directive 2008/98/EC. *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098

Dong, L., Liu, Z., Bian, Y. (2021). Match Circular Economy and Urban Sustainability: Re-investigating Circular Economy Under Sustainable Development Goals (SDGs). *Circular Economy and Sustainability (Online)*, *1*(1), 243–256. https://doi.org/10.1007/s43615-021-00032-1

Ellen Macarthur Foundation. (2019). *Completing the Picture, How the circular economy tackles climate change.* Available at: https://emf.thirdlight.com/file/24/cDm30tVcDDexwg2cD1ZEcZjU51g/Completing%20the%20Picture%20-%20How%20the%20circular%20economy%20tackles%20climate%20change.pdf

Esa, M. R., Halog, A., Rigamonti, L. (2017). Developing strategies for managing construction and demolition wastes in Malaysia based on the concept of circular economy. *Journal of Material Cycles and Waste Management*, *19*(3), 1144–1154. https://doi.org/10.1007/s10163-016-0516-x

European commission. (2020). *Circular Economy Action Plan.* Available at: https://ec.europa.eu/environment/pdf/circular-economy/new_circular_economy_action_plan.pdf

European commission. (2023). *Waste framework directive*. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

European Economic and Social Committee [EESC]. (n.d.). *Embodied Environmental Impact.* Available at: https://www.eesc.europa.eu/glossaries/glossary/lets-speak-sustainable-construction/section/terms/term/embodied-environmental-impact

European Environment Agency. (2016). *Environmental taxation and EU environmental policies. EEA report, NO 17/2016*

European Environment Agency. (2020). *Construction and Demolition Waste: challenges and opportunities in a circular economy.* Available at: ETC/WMGE Report 1/2020: Construction and Demolition Waste: challenges and opportunities in a circular economy — Eionet Portal (europa.eu)

Eurostat. (2023). *Waste Statistics.* Available at: Waste statistics - Statistics Explained (europa.eu)

García, M., Á. (2005). *Challenges of the Construction sector in the global economy and the knowledge society.* International Journal of Strategic Property Management (2005) 9, 6577

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Gerhardsson, H., Andersson, J., Thrysin, Å. (2020). *Återbrukets klimateffekter vid byggnation: Handledning för klimatberäkningar i enlighet med EN 15978.* IVL Svenska Miljöinstitutet. Available at:

https://www.ivl.se/download/18.72fab6cc1761c7ad2941478/1607947586855/C562.pdf

Glasare, G., Haglund, P. (2022). *Återbruk - Arbetsmetodiker*. Offentliga fastigheter. Available at: Återbruk - Arbetsmetodiker (skr.se)

Gupta, S., Chen, H., Hazen, B. T., Kaur, S., Santibañez Gonzalez, E. D. R. (2019). Circular economy and big data analytics: A stakeholder perspective. *Technological Forecasting & Social Change*, *144*, 466–474. https://doi.org/10.1016/j.techfore.2018.06.030

Hallin, A. & Helin, J. (2018). *Intervjuer*. Lund: Studentlitteratur

Hasik, V., Escott, E., Bates, R., Carlisle, S., Faircloth, B., Bilec, M. M. (2019). Comparative whole-building life cycle assessment of renovation and new construction. *Building and Environment*, *161*, 106218–. https://doi.org/10.1016/j.buildenv.2019.106218

Hart, C. (1998). Doing a Literature Review: *Releasing the Social Science Research Imagination*. Open University. https://books.google.se/books?id=FkXvY8oDFdsC

Henriksson, H., & Weidman Grunewald, E. (2020). It All Comes Down to Sales: Up Close: Åsa Bergman, CEO of Sweco, on Partnering with Customers to Build the Sustainable Communities and Cities of the Future. In *Sustainability Leadership* (pp. 109–126). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-42291-2_7

Hickel, J., & Kallis, G. (2020). Is Green Growth Possible? *New Political Economy*, *25*(4), 469–486. https://doi.org/10.1080/13563467.2019.1598964

Hwang, B.-G., & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management*, *31*(2), 272–284. https://doi.org/10.1016/j.ijproman.2012.05.004

IHBC [Institute of Historic Building Conservation]. (2022). *Renovation v refurbishment v retrofit*. Available at: Renovation v refurbishment v retrofit - Designing Buildings

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

Jin, X., Zhang, G., Liu, J., Feng, Y., & Zuo, J. (2017). Major Participants in the Construction Industry and Their Approaches to Risks: A Theoretical Framework. Procedia Engineering, 182, 314–320. https://doi.org/10.1016/j.proeng.2017.03.100

Joensuu, T., Edelman, H., Saari, A. (2020). Circular economy practices in the built environment. *Journal of Cleaner Production*, *276*, 124215–. https://doi.org/10.1016/j.jclepro.2020.124215

Kirchherr, J., Reike, D., Hekkert, M. (2017). *Conceptualizing The Circular Economy: An Analysis Of 114 Definitions. Resources, Conservation and Recycling*, 127, 221–232

Korhonen, J., Honkasalo, A., and Seppälä, J. (2018). Circular economy: the concept and its limitations. Ecol. Econ. 143, 37–46. doi: 10.1016/j.ecolecon.2017.06.041

Kovacic, I.; Zoller, V (2015). Building life cycle optimization tools for early design phases. Energy 2015, 92, 409–419
Kraaijenhagen, C., van Oppen, C., & Bocken, N. M. B. (2016). Circular Business: Collaborate & Circulate. Amersfoort, The Netherlands: Circular Collaboration.
Kvale, S., & Brinkmann, S. (2014). Den kvalitativa forskningsintervjun (3 uppl.). Lund: Studentlitteratur.
Larsen, A. K. (2018). *Metod helt enkelt: en introduktion till samhällsvetenskaplig metod* (2nd ed.). Gleerups.
Leliaert, P. J. C., Candries, W., & Tilmans, R. (2003). Identifying and managing IC: a new classification. *Journal of Intellectual Capital*, *4*(2), 202–214. https://doi.org/10.1108/14691930310472820
Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. *Sustainability (Basel, Switzerland)*, *8*(1), 43–. https://doi.org/10.3390/su8010043
Leipold, S., Petit-Boix, A., Luo, A., Helander, H., Simoens, M., Ashton, W. S., et al. (2023). Lessons, narratives, and research directions for a sustainable circular economy. J. Ind. Ecol. 27, 6–18. doi: 10.1111/jiec.13346
Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, *115*, 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042
Lingegård, S., Oelreich, L., Oelreich, K. (2023). *Implementation and management of a circular public procurement contract for furniture*. Frontiers in Sustainability (Lausanne), 4. https://doi.org/10.3389/frsus.2023.1136725
Liu, C.; Wu, Q.; Tang, W.; Liu, Y. (2021). *Carbon emission evaluation of heavy equipment on dam construction site using discrete event simulation*. IOP Conf. Ser. Earth Environ. Sci. 2021, 675, 012027
MacCallum, D., Babb, C., & Curtis, C. (2019). *Doing Research in Urban and Regional Planning: Lessons in Practical Methods* (1st ed.). Georgetown: Routledge. https://doi.org/10.4324/9781315818894
Mahpour, A. (2018) 'Prioritizing barriers to adopt circular economy in construction and demolition waste management', Resources, Conservation and Recycling, 134, pp. 216–227. Available at: https://doi.org/10.1016/j.resconrec.2018.01.026.
Mavropoulos, A., & Nilsen, A. W. (2020). Industry 4.0 And Circular Economy:Towards A wasteless future or wasteful Planet?. Hoboken, NJ:Wiley.ISBN: 978-1-119-69927-9
Moncaster, A. M., & Symons, K. E. (2013). A method and tool for "cradle to grave" embodied carbon and energy impacts of UK buildings in compliance with the new TC350 standards. *Energy and Buildings*, *66*, 514–523. https://doi.org/10.1016/j.enbuild.2013.07.046
Nakamori, Y. (2020). *Knowledge Construction Methodology Fusing Systems Thinking and Knowledge Management* (1st ed. 2020.). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-13-9887-2
Naturvårdsverket. (2021). *Avfall, utsläpp och växthusgaser.* Available at: Avfall, utsläpp av växthusgaser (naturvardsverket.se)
Nußholz, J. L. K., Nygaard Rasmussen, F., & Milios, L. (2019). Circular building materials: Carbon saving potential and the role of business model innovation and public

policy. *Resources, Conservation and Recycling*, *141*, 308–316. https://doi.org/10.1016/j.resconrec.2018.10.036
Nyhlin, M. (2023). *Fabege och Zengun i unikt återbruksprojekt*. Available at: Fabege och Zengun i unikt återbruksprojekt - Byggindustrin
Nyilasy, G., Gangadharbatla, H., & Paladino, A. (2014). Perceived Greenwashing: The Interactive Effects of Green Advertising and Corporate Environmental Performance on Consumer Reactions. *Journal of Business Ethics*, *125*(4), 693–707. https://doi.org/10.1007/s10551-013-1944-3
Oppong, G. D., Chan, A. P. C., & Dansoh, A. (2017). A review of stakeholder management performance attributes in construction projects. *International Journal of Project Management*, *35*(6), 1037–1051. https://doi.org/10.1016/j.ijproman.2017.04.015
Rahman, M. (2022). *Stakeholders in the construction industry*. Available at: Stakeholders in the construction industry - www.howandwhat.net
Remøy, H., Wandl, A., Ceric, D., & van Timmeren, A. (2019). Facilitating circular economy in urban planning. *Urban Planning*, *4*(3), 1–4. https://doi.org/10.17645/up.v4i3.2484
Ritchie, H, (2018). *Global inequalities in CO2 emissions*. Available at: https://ourworldindata.org/co2-by-income-region
Robinson, H. S., Carrillo, P. M., Anumba, C. J., & Al-Ghassani, A. M. (2005). Knowledge management practices in large construction organisations. *Engineering, Construction, and Architectural Management*, *12*(5), 431–445. https://doi.org/10.1108/09699980510627135
Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research methods for business students: 7. ed*. Harlow u.a: Pearson.
Srivastava, P., & Hopwood, N. (2009). A Practical Iterative Framework for Qualitative Data Analysis. *International Journal of Qualitative Methods*, *8*(1), 76–84. https://doi.org/10.1177/160940690900800107
Sommerville, J., & Craig, N. (2006). CRC Press. 1st Edition. (Routledge). 214. ISBN: 9781134198986. https://doi.org/10.4324/9780203030394
Souza, G. C. (2013). Closed-Loop Supply Chains: A Critical Review, and Future Research. *Decision Sciences*, *44*(1), 7–38. https://doi.org/10.1111/j.1540-5915.2012.00394.x
Sweco. (n.d.). *Våga satsa på återbruk nu!*. Available at: https://www.sweco.se/vart-erbjudande/miljo-och-hallbarhet/cirkular-ekonomi/aterbruk/vaga-satsa-pa-aterbruk/
Swedish Institute for Standards [SIS]. (2011). *Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method.* Available at: https://www.sis.se/en/produkter/construction-materials-and-building/buildings/other/ssen159782011/
United Nations. (n.d.). *The 17 Goals.* Available at: https://sdgs.un.org/goals
Tracy, S. J. (2018). A Phronetic Iterative Approach to Data Analysis in Qualitative Research. *The Academy of Qualitative Research*, *19*(2), 61-76. https://doi.org/10.22284/qr.2018.19.2.61
Tyréns. (n.d.). *Ekonomisk hållbarhet.* Available at: https://www.tyrens.se/sv/tjanster/haallbarhet/ekonomisk-haallbarhet/
Vadén, T., Lähde, V., Majava, A., Järvensivu, P., Toivanen, T., Hakala, E., & Eronen, J. T. (2020). Decoupling for ecological sustainability: A categorisation and review of

research literature. *Environmental Science & Policy*, *112*, 236–244. https://doi.org/10.1016/j.envsci.2020.06.016

Vadenbo, C., Hellweg, S., & Astrup, T. F. (2017). Let's Be Clear(er) about Substitution: A Reporting Framework to Account for Product Displacement in Life Cycle Assessment: A Framework to Account for Substitution in LCA. *Journal of Industrial Ecology*, *21*(5), 1078–1089. https://doi.org/10.1111/jiec.12519

van den Berg, M., Voordijk, H. and Adriaanse, A. (2020). 'Recovering building elements for reuse (or not) – Ethnographic insights into selective demolition practices', Journal of Cleaner Production, 256, p. 120332. Available at: https://doi.org/10.1016/j.jclepro.2020.120332.

Vila-Henninger, L., Dupuy, C., Van Ingelgom, V., Caprioli, M., Teuber, F., Pennetreau, D., … Le Gall, C. (2022). Abductive Coding: Theory Building and Qualitative (Re)Analysis. *Sociological Methods & Research*, 4912412110675–. https://doi.org/10.1177/00491241211067508

Völker, T., Kovacic, Z., & Strand, R. (2020). *Indicator Development As A Site Of Collective Imagination?The case of European Commission policies on the circular economy.* Culture and Organization, 26 (2), 103–120.

Wahlström, M., zu Castell-Rüdenhausen, M., Fruergaard Astrup, T., Oberender, A., Jensen, C., Johansson, P., Rudi Wærner, E. (2021). *Strategies and Methods for Implementing CI in Construction Activities in the Nordic Countries.* Nordic Council of Ministers. http://dx.doi.org/10.6027/temanord2021-508

Wennersjö, M., Gerhardsson, H., Moberg, S., Loh Lindholm, C., & Andersson, J. (2021). *Etablering av en storskalig marknad för återbruk i bygg- och fastighetssektorn : Återbruksrelaterade tjänster för att främja en storskalig återbruksmarknad i Göteborgsregionen.* Available at: http://urn.kb.se/resolve?urn=urn:nbn:se:ivl:diva-3405

World bank, (n.d). *Environmental tax.* Available at: Environmental Taxes (worldbank.org)

WSP. (2023). *Återbruk - en viktig del av ett framtidssäkrat samhälle.* Available at: https://www.wsp.com/sv-se/insikter/aterbruk-en-viktig-del-av-ett-framtidssakrat-samhalle

Zhang, L., He, J., & Zhou, S. (2013). Sharing Tacit Knowledge for Integrated Project Team Flexibility: Case Study of Integrated Project Delivery. *Journal of Construction Engineering and Management*, *139*(7), 795–804. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000645

zu Castell-Rüdenhausen, M., Wahlström, M., Astrup, T. F., Jensen, C., Oberender, A., Johansson, P., & Waerner, E. R. (2021). Policies as Drivers for Circular Economy in the Construction Sector in the Nordics. *Sustainability (Basel, Switzerland)*, *13*(16), 9350–. https://doi.org/10.3390/su13169350

Zuo, J., Zillante, G., Wilson, L., Davidson, K., & Pullen, S. (2012). Sustainability policy of construction contractors: A review. Renewable & Sustainable Energy Reviews, 16(6), 3910–3916. https://doi.org/10.1016/j.rser.2012.03.011

Appendix

Interview guide

Views on a Changing Industry

- From your professional background, do you experience that the working procedure has changed when sustainability aspects are becoming more topical?
- Do you consider the construction industry being positioned to adopt new construction methods and innovations?
- How would you define circular construction?
- How would you define reuse?
- How do you validate climate action against the economy?

Demand for reuse

- What do you consider is sustainable construction?
- What drives the demand for reuse?
- What do you look for when hiring consultants for projects?
- How do you work with reuse in projects?
- Any thoughts on different kinds of reuse: for certain projects, certain materials or products?
- Do you follow a framework for how reuse should be implemented in projects?
- What are the biggest challenges when introducing reuse in projects?

Specifically Sweco

- Do you see an increased demand among clients?

Improvement areas

- What changes are needed to make reuse more applicable in projects?
- How does the coordination work with external actors?
- What actors do you consider the most important for implementing reuse?
- Do you consider [*company name*] sells sustainable solutions, if so, how?
- How do you work with consultants?
- What do you look for when hiring consultants?
- Where do you see the reuse market in 10 years?
    - How can [*company name*] affect that?

Specifically Sweco

- What is needed to streamline the reuse process?
- How does the coordination work internally?
- How can the coordination become improved?
- How can you as a consultant influence the coordination?