Circular economy in Danish construction industry

a political economy perspective

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Abstract

The construction industry is experiencing unprecedented growth worldwide, driven by increasing urbanisation, population growth and economic development. While this expansion is beneficial for economic progress, it also poses significant challenges, including environmental impact, resource consumption and increased carbon emissions. To mitigate these negative impacts, it is imperative to adopt strategies that minimize the industry's environmental footprint. Circular economy is recognized by authorities and the construction industry as a valuable tool for the reduction of the impact. However, the transition to circular economy remains slow.

The construction industry is complex, with numerous stakeholders in and outside of a construction project's value chain, each with their roles and interests. Barriers to circular economy have been research many times before, often coming to the same conclusions. The numerous stakeholders have different knowledge and responsibilities and they experience the barriers differently. The studies on the barriers rely on literature reviews as well as interviews and surveys, but seem to miss on the nuances of the barriers. Some of these studies also propose solutions to the barriers, which are often the direct opposite of a barrier. Considering the amount of research done on this topic and rather high awareness about the barriers among the stakeholders, we suggest a new perspective to study the barriers to circular economy in the Danish construction industry: political economy. In this thesis, we direct our focus to change processes, power relations and ideologies, values and perceptions among the stakeholders.

To guide the thesis, we adopted an exploratory approach as a research strategy. With this, we were able to cover a broad spectrum of topics related to the focal point of the thesis, e.g. influence, collaboration, circular economy, while allowing the interviewee to elaborate on topics they find important. Several stakeholders were interviewed and two key reports were utilized to understand the industry's visions and initiatives. As a first step in the political economy analysis, stakeholders in the Danish industry were mapped. Based on their roles and interests, we extracted their relevance for circular economy. Then we analysed the stakeholders' approaches to circular economy, resulting in preliminary speculations about the imbalance between ambitions and influence. Finally, we analyzed and discussed the barriers by the two key publications and those identified through the interviews. While theorized academic barriers might be a good starting point, we found that categorizing the barriers might had resulted in an isolating approach to finding solutions to them. The barriers are mutually interactive and nuanced. Furthermore, by applying the chosen political economy concepts to the second and third analysis, we identified several underlying reasons, the most prevalent of them being reliance on renewable energy for reaching the national climate goal, continuous investment in recycling infrastructure, and vague definitions and targets for circular economy. We encourage the stakeholders in the Danish construction industry to engage in a dialog about some of the underlying reasons and suggest the vague definitions and targets as the first topic.

The thesis covered sector-level analysis of the Danish construction industry by deploying some of the concepts of the political economy. Similar approach can be applied on company level, to identify how business strategies and company's operations affect other stakeholders and promote a thoughtful stakeholder engagement. We also encourage further investigation of barriers to circular economy from a political economy perspective to get a deeper understanding of the interactions between the barriers. This can help develop more cohesive solutions.

Preface

This thesis concludes the fourth semester of the master Sustainable Cities at Aalborg University Copenhagen. Project period was from February 1st to June 7th, 2024.

The topic of this thesis is circular economy in the Danish construction industry, where barriers and opportunities for circular economy are explored from a political economy perspective.

We appreciate the many interviewees who were willing to share their knowledge and experiences with us. This contributed to a valuable insight in the industry, as well as a critical reflection of the challenges and opportunities with implementing circular economy in the Danish construction industry.

We also want to thank our supervisor, Troels Krarup, for the guidance and constructive feedback.

Table of contents

1 Introduction

Denmark's Overshoot Day was 16th of March 2024, representing the date when the demand for natural resources exceeds what Earth regenerates in a year, if all humanity consumed like the Danish society (Earth Overshoot Day, n.d.). The overconsumption of natural resources represents a global concern that threatens the environment, climate, as well as the well-being of future generations. As human population grows and economies expand, the demand for natural resources such as water, soil, forests, and minerals are expected to increase (Bir, 2019). The construction industry is accountable for over 30 % of the extraction of natural resources and 25% of solid waste generated in the world (Benachio et al., 2020). Furthermore, materials used in the construction of buildings combined with building operations account for 37 % of global energy and process-related emissions. To be aligned with reaching the Paris Agreement, the construction industry must reduce environmental impacts and become carbon neutral by 2050. According to the global status report on buildings and construction, the construction industry is not on track with that target (UN Environment Programme, 2022).

Energy consumption and waste generation are closely linked, as energy is used at every stage of a product's lifecycle, from production and transportation to processing and disposal. EU has set a goal for both energy consumption and waste generation to being reduced by 2030. Climate goals have also been set in Denmark and Danish construction industry plays an important role if Denmark is to achieve the reduction of GHG emissions (Energistyrelsen, n.d.). The construction industry is also an important player in the reduction of waste amounts and resource use, as it generates around 5 million tons of construction waste per year, accounting for about 40 % of Denmark's total waste (Miljøstyrelsen, 2022).

To reduce the environmental impact of the construction industry and minimize construction and demolition waste, implementing circular practices for higher material efficiency must be a priority. Therefore, different legislation and strategies have been adopted in recent years, both on EU and national levels. However, the circular transition of the construction industry remains slow. This report focuses on the barriers specific to the Danish construction industry and the stakeholders' role and influence in overcoming them.

2 Background

To gain insight into the efforts directed toward reducing the construction industry's environmental impact, this chapter describes the legislative framework in EU and at national level. This is followed by an introduction of circular economy in the construction industry, including current practices and barriers to circular economy. Key stakeholders in the construction industry are present at the end. Together, this section presents background information that motivated the research question and the approach in this report.

2.1 Legislative framework

Over the last three decades, GHG emissions of the construction industry have increased by 50 % and IPCC emphasizes a proven efficiency of mandatory regulation in lowering the emissions when combined with other regulatory instruments (IPCC, 2022). Below, the legislative framework of the EU and Denmark is described.

2.1.1 Legislative framework of the European Union

In 2021, the European Commission introduced Fit for 55, a package of proposals aiming to achieve a 55 % reduction in GHG emissions by 2030. These proposals entail revising and updating EU legislation to ensure coherence within the regulatory framework (European Council, 2024). As buildings in the EU contribute significantly to energy consumption and GHG emissions, one of the proposals focuses on renewing the Directive on Energy Performance of Buildings (EPBD), which is the first directive described below. Then, the Waste Framework Directive and the New Circular Action Plan are presented, as the EU's efforts to reduce waste amounts. This is followed by the presentation of the purpose and relevant content of the EU taxonomy.

The Energy Performance of Building Directive

In April 2024, the proposal for the new Energy Performance of Buildings Directive was approved by all EU member states (Byrne et al., 2024). The directive sets targets for new buildings, requiring them to meet zero-emission standards. This includes the calculation of the entire life-cycle carbon footprint of new constructions, thereby promoting sustainability from the design phase through to demolition (COM/2021/802 final 2021/0426(COD), 2021).

In 2021, a comprehensive stakeholder consultation process was conducted to inform the development of the new EPBD. The feedback from participating stakeholders strongly supported the need to report GHG emissions over a building's entire life cycle. Consequently, the revised directive now requires mandatory calculations of the global warming potential for all new buildings. The European Commission views this requirement as an essential step toward developing a more circular construction industry. The circular approach to construction, whereby buildings are viewed as material banks, has the potential to significantly reduce the negative environmental impacts of the building stock. This, in turn, will promote greater resource efficiency and sustainability. (COM/2021/802 final 2021/0426(COD), 2021)

Waste Framework Directive and New Circular Economy Action Plan

The EU Waste Framework Directive emphasizes the shift towards a circular economy by highlighting the importance of prioritizing reuse and recycling of products and materials. With a responsibility for sustainable resource management, the directive aims to minimize the environmental impact of waste

by promoting a more circular approach in which materials are reused and recycled rather than discarded (Directive 2008/98/EC, 2024). Furthermore, the European Union has established a target for the construction sector, stipulating that 70% of construction waste should be reused, recycled, or recovered otherwise by 2020. Despite the Waste Framework Directive placing a high priority on waste prevention, levels of waste in the EU have not decreased (European Commission, n.d.b).

In response to this issue, the New Circular Economy Action Plan was adopted (COM(2020) 98 final, 2020). The action plan focuses on promoting sustainable construction materials, including setting standards and criteria for evaluating and labeling the environmental performance of construction materials and encouraging the use of recycled and low-carbon materials. Since the initial publication of the Circular Economy Action Plan in 2015, there has been some progress in the implementation of circular economy activities by member states. However, the overall pace of progress remains slow. The circularity rate, which is defined as the proportion of materials that are recycled and reused, increased by only 0.4 percentage points between 2015 and 2021, and the EU's objective of doubling this rate by 2030 therefore appears challenging (European Court of Auditors, 2023).

EU Taxonomy

To effectively reduce greenhouse gas emissions, prioritizing investments in the green transition is essential. An annual investment of EUR 700B. in the EU is required, with the private sector responsible for providing most of this funding. These investments not only support climate and environmental initiatives but are also expected to create secure and stable jobs, as well as stimulate economic growth. (Document C(2023)3851, 2023)

To direct investments to the areas where they are most needed, the taxonomy and the accompanying Taxonomy Regulation framework were developed by the EU. This framework outlines the activities that companies must report on and specifies the conditions these activities must fulfill to be deemed environmentally sustainable. The technical screening criteria are used to assess these activities to ensure they meet the taxonomy's standards and contribute to its objectives. Construction activities related to circular economy that must be evaluated and reported on cover both the construction of new buildings and the renovation or demolition of existing buildings. To be considered having significant contribution to circular economy, different criteria have been defined for the mentioned activities. Some criteria, e.g. 90 % of construction and demolition waste is prepared for further treatment, cover resource use, and others, such as calculation of the global warming potential of a building's whole life cycle, support the reduction of GHG emissions. (C(2023)3851 ANNEX 2, 2023)

The EU taxonomy makes reporting on the activity's compulsory for companies, consequently enabling them to identify areas for improvement towards making activities more circular. At present, the taxonomy does not mandate companies to prioritize specific activities or dictate the areas and methods of their investments. (Document C(2023)3851, 2023)

2.1.2 Danish legislation

Danish legislation must comply with EU directives, as Denmark is one of EU's member countries. However, it is up to the individual countries how they decide to implement in directive in national legislation and achieve the goals set on EU level (Heron, 2024). This section elaborates on two Danish legislations relevant to the construction industry – The Building Regulations and Ordinance of Waste.

The Building Regulation

The Building Regulations specify the demands of the National Building Act and contain detailed requirements that all new construction must comply with. The requirements ensure that a building is constructed in a way that is satisfactory for fire safety, security, and health considerations (Social- og Boligstyrelsen, n.d.b). In 2023 new requirements were introduced, demanding LCA calculations of all new construction and a GHG limit for constructions larger than 1,000 square meters (BEK nr 1673 af 11/12/2023, 2023). Climate impacts of new construction must be documented before the developer can obtain an occupancy permit (Simonsen, 2023). The climate demands aim to reduce the CO2 emissions from construction and is an outcome of the implementation of the National Strategy for Sustainable Construction (Social- og Boligstyrelsen, 2021). The GHG limits will gradually become stricter towards 2030, and in 2025 the limits is tightened from 12 kg CO2-eq pr m2 pr year to 7,1 kg (Social-, Bolig- og Ældreministeriets, 2024b).

Additionally, The 'National Strategy for Sustainable Construction' provides an action plan for future buildings in Denmark. The strategy includes five different focus areas that will be implemented through the development of tools and legislation. The strategy has been a significant factor in the shaping of the new requirements in the Building Regulation 2018. The requirements introduced in 2023, including comprehensive life cycle assessments and the establishment of a maximum CO_2 emissions limit for larger buildings. The strategy comprises initiatives aimed on the environment and sustainable construction, creating durable buildings of high quality, comprehensive assessments during renovation to minimize demolition of buildings, resource efficient construction, energy efficient and green buildings. (Social- og Boligstyrelsen, 2021)

Ordinance of waste

The Danish Ordinance of Waste is aligned with EU's Waste Framework Directive, which has requirements for the collection and handling of waste by the responsible stakeholders. The requirements demand construction companies to sort their construction waste in a minimum of 10 fractions. Companies that generate less than 1 ton of construction waste per site will not be affected by the rule (BEK nr 573 af 23/05/2024, 2024). The Ordinance of Waste focuses on high recycling rates from companies that generates waste (BEK nr 573 af 23/05/2024, 2024), which can point to construction waste is being mostly downcycled in Denmark (Miljøstyrelsen, 2022).

2.2 Circular economy in the construction industry

Many different definitions of circular economy exist, and a clear and accepted definition of circular construction is still missing. Compared to other consumer goods, buildings are complex, unique, and long-lived products with many different components and materials. Moreover, buildings often have different purposes of use during their lifetime, and thereby different stakeholders controlling the use, which can lead to uncertainty about the reuse of materials and components (Eberhardt et al., 2020). This presents a complex industry, resulting in a complex transition to a circular construction industry. However, implementing circular strategies also presents an opportunity to capture more value in a high-growth and high-waste sector like the construction industry (ING, 2017).

Many methods for a more circular construction process already exist, including circular solutions across the value chain to replace linear products and practices. Methods such as assembly/disassem-

bly, material selection/substitution, adaptability/flexibility and modularity are often represented in literature on circular construction strategies. However, a wide-scale adoption of these methods is still lacking. Furthermore, a fragmented development of initiatives for circular construction going in different directions can potentially prevent a universal adoption of circular construction. (Eberhardt et al., 2020)

2.2.1 Circular construction practices in Denmark

With around 40 % of Denmark's total waste amount coming from construction and demolition waste, and approximately one-third of all construction and demolition waste being recycled, Denmark is lacking the implementation of circular construction (Miljøstyrelsen, 2022). However, there is a growing movement within the construction industry to challenge the traditional linear value chain that typically beings with extractions of resources and ends with waste (Realdania, 2020).

In recent years, there has been an increase in initiatives and projects in Denmark aimed at developing circular building materials and processes. One of the most recognized projects is Circle House which is a recently completed construction project consisting of 60 non-profit housings built according to the principles of a circular economy. The goal was for 90% of the building materials to be reusable without significant loss of value. Thereby the principle of design for disassembly was applied in the project. The project involved over 60 companies from the Danish construction industry (Rådet for Grøn Omstilling, 2023). Examples of circular principles applied in construction is also seen in different municipalities' construction projects. Roskilde Municipality constructed a parking garage with the use of reused and recycling materials, and with the intention that it can be repurposed for a different use in the future (Danske Arkitektvirksomheder og Bygherreforeningen, 2023). Aalborg Municipality have construction project where they have incorporated circular solutions, such as lifespan for the building, operation of the building, and using reused and recycled materials (Realdania, 2023a).

In recent years, large sums have also been allocated from both public and private funds to development and demonstration projects, and several partnerships have emerged among companies, investors, and research institutions around circular construction projects e.g. 4-1 Planet project funded by Villum Funden and Realdania, and the Circle House project supported by the Environmental Protection Agency and Realdania. (Rådet for Grøn Omstilling, 2023).

In 2015, Ellen MacArthur Foundation made an analysis of the financial potential of circular economy in Denmark showing one of the biggest potentials in the construction industry. The analysis concluded that reuse and high-value recycling of materials can result in a net value of DKK 0,8-1,1 b. per year in 2035. Despite financial potential in circular construction in Denmark, as well as recent innovation projects, the commercialization of circular solutions in construction is still missing. (Rådet for Grøn Omstilling, 2023)

2.3 Barriers to circular economy in the construction industry

Existing literature presents different classifications of barriers to implementing circular economy. The study by Kirchherr et al. (2018) identifies four categories of barriers, drawn from a literature review of studies on circular economy barriers and supported by a survey of over 200 business and governmental stakeholders and almost 50 interviews with circular economy experts within the EU. The categories are cultural, technological, market, and regulatory. Some studies, like the one by de Jesus &

Mendonça (2018) consider technological barriers, such as inappropriate technologies, as crucial to overcome, Kirchherr et al. (2018) identify other most pressing barriers. The two most pressing barriers are a lack of consumer interest and awareness and a hesitant company culture categorized under the cultural barriers. According to the study, the third most pressing barrier is the low price of raw materials under the market barriers. Besides the barriers, the authors also identified the interactions between them, where some barriers reinforce others: low raw material costs discourage consumers' interest in circular materials and products, reinforcing hesitant company culture (Kirchherr et al., 2018). The interactions might create a chain reaction of the resistance to circular economy.

Inspired by Kirchherr et al. (2018) and other studies, Munaro & Tavares (2023) identify barriers and drivers for circular economy in the construction industry and classify them into five categories: economic, informational, political, and technological. The study reveals that political (i.e. regulatory) and technological barriers are the most prominent. This underscores the necessity for a comprehensive governance policy that includes regulatory initiatives within the construction industry, as well as the development of an integrated system for waste management and information. According to Munaro & Tavares (2023), it is essential to identify and understand the barriers, drivers, and stakeholders that can influence improvements in construction practices. This understanding is crucial for effectively conceptualizing and implementing a circular economy within the industry.

2.4 Stakeholders and value chain of a construction project

The construction industry includes many stakeholders and a complex value chain of interdependent and interacting stakeholders. Stakeholders in construction industry have been identified in many academic papers. Doloi (2013) identifies the three key stakeholders in construction projects as clients, consultants, and contractors. In Shooshtarian et al. (2020), the key stakeholders are identified as government & policymakers, manufactures & suppliers, architects, engineers, and builders. In a systemic literature review on barriers and drivers towards circular economy, a total of 29 stakeholders were identified in construction industry and grouped into clients, projects professionals, suppliers, public, and government (Munaro & Tavares, 2023). In a publication by Ellen MacArthur Foundation in 2022, three stakeholders are identified as those with the greatest capacity to influence decision-making and kick-start action throughout the value chain. This involves policymakers, investors and developers. The same key stakeholders are mentioned in the Roadmap for circular construction, which is a publication outlining a common vision and possible initiatives for circular principles in the Danish construction industry. Policymakers can create and implement policies that encourage circular economy, they can promote awareness and making it more attractive for businesses. Investors can prioritize funding for projects that incorporate circular principles, by choosing to invest in circular projects, and drive the market towards circular solutions. Developers are those responsible for the design and construction of buildings, and therefore they are crucial in making demand for more circular practices in their construction projects (Realdania, 2023b).

Even though circular solutions already exist across the value chain, collaboration, and partnerships between stakeholders in the construction industry is essential for successful transition and to overcome current barriers. This also involves new alliances between companies in new and established production chains. Business models and approaches must be replaced to change the linear model. (Holland Circular Hotspot, 2022). An increased collaboration among stakeholders is identified as a crucial factor for creating a circular resource flow of CDW products (Shooshtarian et al., 2020). And

effective collaboration can address a number of barriers, such as lack of information, poor planning, insufficient legislation, and financial incentives.

The involvement of governments and policy makers is also essential, as they can create the necessary regulatory framework and financial incentives to support circular construction initiatives. Manufacturers and suppliers can contribute by developing and providing circular materials and technologies. In essence, the transition to a circular economy in construction is not just a technological or logistical challenge, but a collaborative one that requires a concerted effort from all stakeholders.

2.5 Summary

In recent years, the construction industry and circular economy have been gaining the attention of the authorities, becoming subject to gradually more and more regulation. Besides mandatory requirements, sustainability reporting like the EU taxonomy has been introduced. The taxonomy ensures more transparency on the sustainable activities of companies and can steer investments where they are needed. Circular economy offers many different possibilities, and the construction industry is also challenged by different definitions and approaches. Besides the many different circular principles, practitioners meet barriers to circular economy, that hinder its implementation. Academic research has identified several possible barriers underlining the importance of understanding the drivers for circular economy and the role stakeholders play in that.

3 Research question

In this chapter, our motivation for the research question and the approach to the thesis is illustrated first, followed by the research question and problem delimitation.

3.1 Our motivation

The transition to circular economy in the construction industry has been slow, despite growing awareness of its environmental benefits. The evidence indicates that the EU Commission's Circular Economy Action Plan has had a limited impact on the implementation of circular economy activities in the member states (European Court of Auditors, 2023). This lack of progress can be attributed to a complex set of interrelated factors. In Denmark, the construction industry is characterised as conservative, where traditional practices and the mindset of linear practices often dominate (Realdania, 2023b), creating difficult conditions for those, who want to engage with circular economy. This thesis addresses our ongoing frustration. Although the circular economy is a well-researched concept, it is often treated as a novelty. Despite frequent identification of barriers and solutions, and growing awareness among academics and companies, the construction industry remains hesitant to adopt it. The academic studies on barriers to circular economy mentioned above (see 2.3) are primarily literature studies of other academic studies. We propose a new approach to the barriers to circular economy: political economy. Our approach is inspired by key questions from political economy, such as what drives change, what is considered valuable, and what shapes the market. Our aim is not only to contribute to academic research but also to encourage a broader, more nuanced dialogue among industry stakeholders. While we contribute to the academic research, we especially direct the research question toward the Danish construction industry and their experiences with the barriers.

3.2 Research question

The research question we aim to answer with this thesis is:

How can political economy analysis contribute to the stakeholders' understanding of barriers to circular economy in the Danish construction industry and encourage an intricate dialog to accelerate the implementation of circular strategies?

We elaborate on the key concepts of the research questions, relations between them and how we utilize them to research the barriers and the Danish construction industry in section 4, 5, and 6.

3.3 Problem delimitations

Here, the delimitations that have been chosen in this thesis are described.

Political economy: Political economy analysis is a comprehensive analysis, requiring extensive resources. Consequently, we have selected concepts found relevant in the context of the Danish construction industry, which is further elaborated in section 5.

Stakeholders: This thesis aims to have a broad perspective of the construction industry. Due to the extensive scope of stakeholders and limited available time, we prioritized interviews with some of the most visible stakeholders and those we had access to through personal contact (see 6.1.1)

Danish construction industry: The construction industry consists of many types of construction, incl. roads and other infrastructure. This thesis focuses on the construction of buildings.

4 What is meant by circular economy

This section explains how the term circular economy is understood and used in this thesis. First, circular economy as a broad concept is explained, followed by how circular economy and related terms are used in this thesis. Then a discussion on circular economy as an economic system is initiated by illustrating the limitations of current academic research. This chapter serves as a basis for understanding how circular economy as a concept shaped the rest of the thesis and leads to the choice of theoretical perspective.

4.1 Circular economy as a broad concept

The concept of circular economy builds on the idea that materials and products circulate indefinitely, removing the need for extraction of non-renewable raw materials. This idea is the driver for three circular principles: 1) eliminate waste and pollution, 2) circulate products and materials, and 3) regenerate nature (EMF, n.d.). While these three principles might give an impression of a rather straightforward approach, interpretations of how the principles should and could be addressed are plentiful.

A recent study by Kirchherr et al. (2023) reviewed and analyzed 221 definitions of circular economy. The most reoccurring circular economy terms in the study are recycle, reuse, and reduce, often referred to as 3R (Kirchherr et al., 2023) or R-strategies (Potting et al., 2017). While most of the reviewed literature mentions the three R-strategies, some literature suggests other strategies, that fit into the framework. For example, reduce and rethink do not necessarily paint a circular image, but are considered a circular strategy as they contribute to lower consumption of materials and consequently reduction of waste (Potting et al., 2017). The R-strategies should be applied in the product design phase to reduce the amount of needed resources while maintaining the original function of the product. Depending on the applied R-strategy, stakeholders in the product's value chain are affected differently (Potting et al., 2017). For example, a high focus on the repairability of a product can result in a higher need for interactions between consumers and suppliers, while a high focus on using recyclable materials can result in a higher need for waste sorting and management infrastructure.

R-strategies are not the only strategies used by scholars. For example, slow, narrow, close, regenerate and inform are strategies in a flow model of circular economy to broaden the application of circular economy from a product to a system (Konietzko et al., 2020). The flow strategies appear in the study by Kirchherr et al. (2023) either as a stand-alone term (regenerate) or as a part of the R-strategies. The term inform is not included in the mentioned study. The flow strategies can, similarly to R-strategies, be applied to product design; narrow can encourage ways to reduce the amount of needed material or replace impact-heavy material with a material with similar properties but less negative impact. When narrow is applied to a product's value chain, this strategy can encourage collaboration and approaches that reduce the use of resources in the product's whole lifecycle (Konietzko et al., 2020).

As circular economy has been gaining attention (see 2), the definitions of circular economy have been multiplying. The myriad of definitions seems to have affected the development and implementation of circular principles in the construction industry (Munaro & Tavares, 2023). Above, circular strategies that can be applied to a product are mentioned, where a product is a result of a production process. In the context of the construction industry, a building can be seen as a product of a construction process. Across the building's lifecycle, 30 different ways of applying circular strategies have been identified. As an example, five design strategies are possible to apply when designing a building: 1)

design for disassembly, 2) design for adaptability and flexibility, 3) design for standardization, 4) design out waste, and 5) design in modularity (Adams et al., 2017). Depending on which design strategy is applied, the impact on the environment can be different. While designing a building for disassembly can simplify careful demolition and consequently increase the reuse of the building's components and minimize waste at the end of the building's life, it might not encourage designing out waste in the construction stages of the building. Achieving the EU's objectives regarding the circular economy and environmental impact of the construction industry (see 2) can thereby be hindered if the stakeholders in the industry take different approaches.

There seems to be a more unified understanding of how circular economy should be approached by the construction industry in Denmark. In 2023, a common vision for circular economy was developed (Realdania, 2023b), defining circular economy in the Danish construction industry beyond the previously mentioned circular economy strategies. A year later, in 2024, the Action tank for sustainable construction also published a report with a common vision of the Danish construction industry, spanning over three focus areas, GHG emissions, circular economy and biodiversity, where less resource consumption and more reuse are highlighted (Handletank for bæredygtighed, 2023). Both reports agree on the necessity of more renovation and less new construction, but the Roadmap for circular construction also recognizes adjustment of architectural aesthetics as a part of circular principles. Both reports claim to be the Danish construction's industry's common vision, but the visions don't seem to be aligned.

4.1.1 Circular economy in this thesis

Considering the above, numerous definitions of circular economy, many ways of applying circular economy in the construction industry, and apparent misalignment in two of the key documents for circular economy in the Danish construction industry, we use circular economy in this thesis to identify what the stakeholders in the Danish construction industry prioritize and whom they might favor collaborating with we engage with low-level and high-level circular economy, depicting the effect different circular economy strategies have on the reduction of the negative impact. In the table below we collected and described the circular economy terms we use in this thesis.

Table 1: Circular economy terms in this thesis.

Circular economy	Refers to circular economy in general when further distinction is not crucial to the context.
Circular principles	In academic literature terms like reuse, refurbish and recycle are referred to as strategis. Later in the thesis we analyze the stakeholders' strategic approach to circular economy and often use the term 'strategy'. To avoid confusion, we instead use 'circular principles' when referring to the mentioned circular strategies.
Circular activities and circular practices	Sometimes, neither circular economy nor principles are context-fitting. Circular activites and practices encompass activities related to the implementation of development of circular principles, such as collaboration with relevant stakeholders where circular principles are focal point.
Circular construction industry	We recognize that a circular construction industry strikes one as utopian. We use the term to refer to an industry that is constantly evolving, breaking linear habits and implementing a higher share of high-level circular economy compared to low-level. In this context, the construction industry doesn't only go through technological but also organizational changes.

High-level circular economy	To avoid constant use of terms like reuse and renovate, we sometimes use the term 'high-level' circular economy, which encompasses circular principles with highest potential for the reduction of the negative impact. This term covers circular principles like reuse and preparation for reuse, reduction, renovation and transformation, and design for disassembly.
Low-level circular economy	To avoid constant use of terms like recycle and demolish, we sometimes use the term 'low-level circular economy', encompassing circular principles with lowest potential for the reduction of the negative impact. This term covers terms like recycling, incineration, other final material recovery and demolition.

4.2 Circular economy as an economic system

Circular economy is often utilized as a set of strategies to manage resource use. In its broadest meaning, circular economy can be defined as an economic system (Korhonen et al., 2018). An economic system is "a massively complex structure of rules that have evolved over a long period of time" (Dopfer et al., 2004, p. 266 (4)) and relate to the production and consumption of products and services. An example of such a rule is the organizational structure of a company in support of optimized production logistics. The rules of an economic system are placed in a wider landscape of rules: political, behavioral, social, legal and others (Dopfer et al., 2004).

The current, linear, economic system evolved on the idealization of new, creating a set of rules supporting extraction, consumption, and disposal of new materials and products (Parrique, 2019). In contrast to the linear economy, where the structure of rules is well established, circular economy as an economic system and consequently its structure of rules is still evolving (Korhonen et al., 2018). Besides the evolving set of rules, circular economy must also navigate the established structure of the linear economy rules. In the context of the construction industry, methods for testing the properties of materials can be considered linear, as they can be applied to new materials and products. Such tools are not yet fully developed for circular materials and products (Munaro & Tavares, 2023).

Korhonen et al. (2018) identified several limits for circular economy as an economic system. Materials and products flow across several spatial boundaries, affecting not only those engaging with circular principles, but the whole value chain and a broader environmental and social networks. Introduction of sustainable practices has previously proven to have problem-shifting effect, where the benefits on the local environment translated into environmental and social damage outside the local boundaries. Furthermore, existing infrastructures with associated collaborations, discourses and financial investments dominate the market, creating a thick wall that circular economy must break through. Besides the established infrastructures, organizational barriers also challenge circular economy, where issues such as responsibility, gains, losses and risks emerge. Definitions of terms also present a challenge for circular economy. Cultural aspects influence the meaning of terms, and along with changing cultures, definitions are also dynamic. For example, waste has traditionally been seen as value-less. With a shift in culture and perceptions, waste has gradually gained value and is now seen as a resource with economic benefits (Parrique, 2019). With focus on recycling, other circular principles might be left behind. We see these limits as the set of rules that circular economy must navigate. Established infrastructure with associated aspects and organizational practices can be linked to the well-developed linear set of rules, and problem-shifting effect and cultural aspects can be connected to the wider set of rules that economic systems must navigate.

4.2.1 Economic set of rules in this thesis

The wider set of rules, such as social, behavioral, and political can be defined as rules developed by society (Schofield & Caballero, 2011) and we believe that this wider set of rules has been greatly shaped by the values of linear economic system. Political rules are formalized rules like laws and regulations, and social and behavioral rules are developed by cultural norms and conventions (Source Schofield). The limits to circular economy explored above suggest similarities with the barriers identified by Kirccherr et al. (2018). Considering the specific barriers, for example, we link operating in a linear system and low virgin material prices (Kirchherr et al., 2018) to the established set of linear rules, and hesitant company culture and obstructing laws and regulation (Kirchherr et al., 2018) to respectively social/behavioral and political set of rules. In this thesis, we therefore equal the barriers with the set of rules that circular economy must navigate.

Korhonen et al. (2018) recognize that some aspects of circular economy have been researched plenty, but contend that circular economy has not been researched enough as an economic systems positioned in the mentioned limitations. Academic research on barriers to circular economy seems to be primarily done through literature reviews and qualitative methods revolving around barriers. To categorize the barriers and identify the most pressing ones (see 2.3), Kirchherr et al. (2018) reviews over 30 academic studies on the barriers to circular economy. The reviewed studies are mainly based on literature reviews, e.g. de Jesus & Medonca (2018), based on literature reviews, e.g. Rizos et al. (2015). Many of the reviewed studies are also based on qualitative methods, including the one by Kirchherr et al. (2018). The interview guides and workshops seem to revolve about perceived barriers to circular economy and how to overcome them (e.g. Kirchherr et al. (2018), Rizos et al. (2015)). The study by Munaro & Tavares (2023), another literature review, identifies barriers specific to the construction industry and categorizes them into categories similar to Kirchherr et al. (2018). Besides the barriers, Munaro & Tavares (2023) identify the drivers for circular economy in the construction industry. Most of the suggested drivers are a direct opposite of the barriers or a combination of several barriers. For example, negative public perception because of lack of communication, trust and awareness is suggested to be solved by raising awareness through electronic media, campaigns and advertising. For overcoming lack of tax system, different solutions are suggested, e.g. tax exemptions and reduction of taxes on labor (Munaro & Tavares, 2023). This aligns with perceptions of those who practically engage with circular economy, who somehow believe that if circular technologies and business models prove to be superior this will persuade the linear, established, systems to adapt (Korhonen et al., 2018).

Even with extensive research on barriers and drivers, circular economy is far from being wide-spread (see 3). Therefore, we suggest an approach, that differs from the prevalent academic approach described above to broaden the perspective and hopefully gain an understanding of the barriers that can help both practitioners and academics tackle the barriers with nuanced or mutually dependent solutions. The new perspective, political economy and political economy analysis and relevant concepts are explored and discussed in the next chapter.

5 Theoretical framework

This chapter starts with a short presentation of political economy as a theory – its historical beginnings and development over time and its typical application by scholars and financial institutions, including political economy analysis as a framework. This is followed by a presentation of how political economy and political economy analysis have been applied to circular economy and the construction industry and a discussion of how the two concepts are used in this thesis.

5.1 What is political economy

During the first industrial revolution, which marked significant shifts in production and distribution to meet society's growing needs and desires, the concept of political economy emerged. This term brought into scrutiny the state's role in managing economic activities and debates emerged on the state's responsibilities towards satisfying societal demands (Caporaso & Levine, 1992). Initially, political economy was a scientific approach guiding the state in administering resources to generate wealth (Weingast & Wittman, 2008). Over time, the concept of political economy branched out into various approaches with a similar goal: to understand and determine how much political involvement is needed to shape and evolve markets to fulfill societal needs and desires (Caporaso & Levine, 1992).

Krätke & Underhill (2006) identify four primary branches of political economy: classical, radical, international, and comparative. Classical political economists contended that economic systems and the distribution of resources are not conditioned by irrational behavior. In contrast, radical political economists challenged this belief, claiming that historical socio-political interactions significantly influence systemic dynamics. International and comparative political economy extend the analytical focus, examining the dynamics among regional systems within the broader global framework (Krätke & Underhill, 2006). Based on these four branches, Jessop & Sum (2001), introduced a fifth approach, cultural political economy, which expands the boundaries even further. It incorporates new methodologies and tendencies, such as discourse analysis and geopolitical studies, to enrich the understanding of economic systems. This approach recognizes that economic activities are embedded within broader cultural and political contexts, implying the necessity of interdisciplinary insights.

In the last decade, comparative political economy experienced a revival. Besides the understanding of the dynamics between politics and economic systems, this branch of political economy studies outcomes: how the economy influences political choices and how political choices impact economic development. The objective of comparative political economy is to understand the interactions between the market and institutions and identify who has the power to drive the change (John, 2017). Political economy studies, including comparative political economy, often deal with questions concerning labor division and welfare-related issues, but can also be used to understand the dynamics between economic systems and politics on a sector level. Recently, the environment has become a topic of interest in political economy to analyze potential outcomes of environmental policies and propose improvements to policies (John, 2017). For example, Niu et al. (2024) found an increased interest in a relationship between political economy and green innovation, where studies focus on how political connections influence the development of strategies for green innovation.

5.2 What is political economy analysis

Political economy analysis (PEA) is often used to study the political economy of a certain phenomenon. PEA examines how relationships, incentives, and power distribution between different societal groups influence outcomes and consequences of political interventions (Mclougglin, 2014) and is often used by financial institutions and governments to support the development of sectors. For example, both World Bank and the Danish Ministry of Foreign Affairs tested the application of a PEA framework to support reforms and capacity development in developing countries (Danida, 2011).

Political economy analysis can be applied at country, sector, and project level. Country level analysis provides a detailed qualitative overview of political economy drivers for the country overall. Sector level analysis can concern specific themes e.g. resource management, focus on drivers for a specific sector, or a combination of both. Project level analysis can focus on a single policy decision or a specific project. One can either focus on one level or cover more levels. (Poole, 2011)

Andreas et al. (2021) seem to be the firs to apply PEA to the construction industry in the UK. The research revealing the stakeholders' flawed assumptions about who has the power and flexibility to lead the change. Considering the lack of political economy application to the construction industry, we assume the lack of PEA application to the circular transition of the construction industry. We believe that the use of such a framework can reveal assumptions and practices within the industry that explain (some of) the barriers to CE mentioned above.

5.3 Political economy and political economy analysis in this thesis

One of the questions that political economy aims to answer is "What is the source of value?" (Parrique, 2019). In linear economic system, materials lose their value upon disposal, encouraging continuous consumption of new raw materials to generate value and wealth. This notion generates significant waste amounts, a trend also observed in the construction industry. Considerable recycling and other recovery of waste (Miljøstyrelsen, 2022) can redirect the focus toward waste as a source of value, resulting in resistance to circular principles that encourage the prevention of waste. From the perspective of psychoanalysis and political philosophy, Valenzuela & Böhm (2017) discuss the political economy of waste: how the discourse on waste shapes consumption and disposal patterns. They argue that marketing recycled and otherwise circular products allows for a false sense of contribution to waste reduction, consequently encouraging more, not less, consumption.

In line with circular economy being viewed as an economic system, evolving its set of rules in the already established linear set of rules (see 4.2), we believe that how the stakeholders approach circular economy influences the development of the rules. Driven by the key objective of comparative political economy – to identify who drives the change – we intent to explore how stakeholders engage with circular principles and what is the rationale behind their choices.

This understanding is crucial for grasping the dynamics of the transition and its implications for each stakeholder (Moncrieffe & Luttrell, 2005). Furthermore, understanding how each stakeholder engages with CE practices provides insights into the legislative and voluntary initiatives they may support in the future and the potential collaborations they may favor.

A political economy perspective, as outlined above, requires an operationally-useful conceptual framework that emphasizes the importance of context, power, institutions, actors, and processes. The

key objective of PEA is "*to find out what is really 'going on' in a situation, what lies behind the surface of the immediate problem*" (Whaites, 2017, p. 4). Besides the potential deviations of circular economy definition among the stakeholders in the Danish construction industry (see 2.4), we believe that the barriers to circular economy can be researched further to find what lies behind – the underlying reasons.

The main PEA framework used in this thesis provides a guideline for the analysis of the political economy of a specific sector (Moncrieffe & Luttrell, 2005), applied in this thesis to the Danish construction industry. With that, the framework can provide a better understanding of the structure of rules in the industry, potentially revealing barriers to circular economy that have not been identified before, or explaining why certain barriers exist.

To analyze the industry, the PEA framework provides a set of categories (see 5.3), that guide the analysis of stakeholders in the industry. Categories found relevant in this thesis are: 1) Traditional authorities, 2) State institutions and legislative, 3) Key sector ministries, 4) Associations and social movements, 5) NGOs, 6) Citizens, clients and other groups, and 7) Privat sector. The private sector is limited to only one category in the PEA framework but the construction value chain contains a variety of different stakeholders, most of them within the private sector. Therefore, categories from the PEA framework are supported with literature on construction stakeholders (see more in 5.3).

Furthermore, the PEA framework suggests different lenses to explore the industry. This thesis focuses on three of the lenses: 1) change processes – reasons for shifts in policies and the role of crisis, 2) power relations – key actors and how power relations influence policy processes, and 3) ideologies, value, and perceptions – influence of values on policy formulation and the mismatch between rhetoric and outcomes (Moncrieffe & Luttrell, 2005). Lenses are chosen based on initial research results outlined in chapter 2. New legislation, stricter requirements and EU taxonomy all argues for the relevance of exploring change processes. Identified key stakeholders in construction with great possibilities to drive the change argues for further research of the power relations between stakeholders. Last, the slow circular transition despite of environmental and financial advantages suggests strong ideologies in the industry hindering the change.

6 Methodology

This chapter outlines the methodology of the thesis. It begins by detailing the research design, including the research strategy, the selection of the interviewees, and the choice of key reports. Following this, the primary data-collection method, semi-structured interviews, is introduced. Finally, the chapter describes the analytical approach, explaining the analysis and discussion process, and outlining the main steps involved.

6.1 Research design

To guide the thesis' choice of methods and their application, an exploratory approach is adopted as a research strategy. The exploratory approach is appropriate for quantitative research of unfamiliar and complex phenomena, offering flexibility to explore various angles and perspectives (Elman et al., 2020). Given a new perspective applied to investigate the barriers within the Danish construction industry to gain a deeper understanding of the barriers than that offered by the traditional academic approach (see 3.1), the exploratory approach is deemed fitting. Furthermore, the PEA framework emphasizes the researcher's role in prioritizing and re-prioritizing issues they consider significant, given the context, and adjusting as needed (Moncrieffe & Luttrell, 2005). There is not a set structure or methodology to follow, and multiple methods of data collection can be used, but exploratory research often rely on qualitative data (Elman et al., 2020).

The research design of this thesis is divided into three overall phases (Table 2). The research design began with reviewing a broad scope of existing documents and academic papers on circular economy in general and in the context of construction. This included studying literature reviews, providing a good overview of existing knowledge in the field. Furthermore, research was done on the EU and national legislation to gather information on recent legislation related to the construction industry and circular economy. Since we had an interest in exploring the Danish construction industry from a political economy perspective, literature about and cases using this theory was researched. This led to the second stage of the research design, where theoretical concepts relevant to the analysis and the discussion were chosen. These concepts were also used as an inspiration for the interview guides as well as the development of working questions. This stage involved interview coding to prepare empirical data for the analyses.

Table 2: Key activities in the three phases of the research.

Phase 1 →·	Phase 2 →·	Phase 3
- Reviewing circular economy literature: literature reviews of circular economy in general and construction specific. - Researching recent legislation on EU and national levels - Exploring political economy literature and cases	- Building a theoretical framework and selecting concepts from political economy analysis - Developing interview guides and conducting interviews with selected stakeholders - Developing working questions to support research question	- Interview coding to structure analyses and discussion - Writing analyses and discussion - Answering the thesis' research question

Before delving into the reports used in this thesis, the following section presents the primary sources of the thesis – the interviewees – and explains the rationale behind their selection.

6.1.1 Selection of interviewees

Various stakeholders within the Danish construction industry have been interviewed. The stakeholders either represent specific parts of the value chain or the construction industry as a whole. Hence, they have different functions and possess different types of knowledge regarding the construction industry.

Interviewees were selected based on their positioning in and outside the value chain. To cover a broad spectrum of the construction industry, the stakeholders in the value chain were chosen based on their main activities, e.g. developers, construction company and manufacturer. The stakeholders outside the value chain often advocate for different interests, and therefore we chose those that advocate for the interests of the industry and those that advocate for the interests of the climate and broader society. Some of the interviewees we know personally and access to other interviewees was gained through personal contact. Besides the selection criteria described above, engagement with circular economy, extensive knowledge and experience in their respective fields were crucial for us. A total of 10 stakeholders were interviewed (during the last interview, two employees were present), creating a manageable amount of data of varied opinions and experiences. Besides the interviewed stakeholders, we contacted other stakeholders in hopes of including stakeholder groups, such as architects and demolition companies, but without luck.

Interviews are a qualitative method where personal experiences, understandings, and values are expressed. Statements from the interviewees, therefore, cannot generalize how things are everywhere in the construction industry and therefore we also looked for agreements or opposite opinions on the same topics. Some of the interviewees held different positions at different organizations within the construction industry and were able to provide a broader understanding of the dynamics within and between the stakeholders. Table 3 offers an overview of the interviews. Table 4 on the next page shortly introduces the organizations that each interviewee represents.

Tabel 3: An overview of the interviews conducted for this thesis. The table presents the organization where each interviewee is employed, their positions, when the interview was conducted and where in the appendices the notes to each interview can be found. The interviews are listed in chronological order.

Organisation	Position	Date	Reference
KAB	Senior consultant	21/2 2024	Appendix 1
DI	Deputy Director, Head of Danish Infrastructure	4/3 2024	Appendix 2
Norrecco	Administrative director	8/3 2024	Appendix 3
Circue	Co-founder	12/3 2024	Appendix 4
Concito	Senior advisor	14/3 2024	Appendix 5
Pension Danmark Ejendomme (PensionDenmark)	Head of Sustainability	19/3-2024	Appendix 6
Brødrene A&O Johansen (AO)	Head of Climate & Sustainability	2/4-2024	Appendix 7
Arpe & Kjeldsholm	Responsible for Sustainability	5/4-2024	Appendix 8
Letbek A/S	Material Specialist	16/4-2024	Appendix 9
Finn L. & Davidsen A/S (FLD)	Strategic Market Manager and Communication & Sustainability Manager	23/4-2024	Appendix 10

Tabel 4: Short introduction of the organizations that the interviewees represent. The information about the organizations in this table is collected from the organisations' websites.

Organization	Description
KAB	Denmark's largest administrative organization of non-profit housing. They construct, lease, and manage public and municipal housing. They also provide services in areas such as energy management and construction consultancy and handle tasks as construction projects managers both in new construction and renovations. (KAB, n.d.)
DI Construction	The largest industry association under the confederation of Danish Industry (DI), representing around 6,700 companies in construction, civil engineering, and the building industry. One of the main tasks is to actively participate in political debates and ensure a strong profile for the construction industry and its stakeholders and thereby be a visible spokesperson for the entire industry and promote policy interests of the members. (DI Byggeri, n.d.)
Norecco	Receive construction and demolition waste from new construction, renovations, and demolitions. They aim to maximise recycling and save natural resources by processing construction waste into resources that can enter the economy again. Norrecco has the certified environmental management system ISO 14001. (Norrecco, n.d.)
Circue	A digital platform that aims to become a collaboration hub for a circular construction. The project is a collaboration between Circue Aps and a number of stakeholders, including twentyfifty futures, MATTER bytrix, J. Jensen A/S, Third Nature, HD Lab and others. Circue wants to create a circular value chain that can compete with linear construction practices by being scalable and cost-effective. (Circue, n.d.)
Concito	Denmark's green think tank and an independent knowledge partner for decision-makers across society. There work is organised in concrete programs and one of them is buildings. Through scientific and knowledge-based analyses and information they show how to make the transition to a more sustainable buildings and construction processes. (Nielsen, n.d.)
Pension Danmark	A Danish pension company founded in 1992 and owned by 11 trade unions and 29 employers' associations. Pension Danmark's task is to ensure members a good return after tax and inflation on their savings. Therefore, PensionDanmark invests in infrastructure, credit, and properties. Within infrastructure and properties, they set standards for sustainability and for this purpose, they primarily use the certification scheme DGNB. (PensionDanmark, n.d.a, n.d.b)
AO	Brdr. A & O Johansen (AO) is a wholesale company established in 1914 with 57 stores in Denmark and 5 in Sweden. AO's core competences are plumbing, electricity, tools, fittings, "VA" and water supply. (Brd. A&O Johansen, n.d.)
Arpe & Kjeldsholm	Construction company that advises, plans, and executes large and complex construction projects within infrastructure and buildings. Operates primarily in Greater Copenhagen as total enterprise or client consultant. (Arpe & Kjeldsholm, n.d.)
Letbek	A manufacturing company of plastic products that recycles plastic into new items, among other, to the construction industry. (Letbek, n.d.)
FLD	Finn L & Davidsen A/S (FLD) is a construction company specialized in electrical installations and plumbing. They primarily do larger construction projects, insurance cases, property renovation, and maintenance. They employ approximately 230 people. (Houengaard, n.d.)

6.1.2 Selection of key reports

Two reports are viewed as central to this thesis, as they represent the construction industry's vision and initiatives for circular economy: 1) The Construction industry's Action tank for sustainability report (Handletank for bæredygtighed, 2023) and 2) Roadmap for circular construction (Realdania, 2023b).

The reports are developed by the private sector, both in collaboration with a wide range of stakeholders, thereby representing the interests of the Danish construction industry. Similarities and differences of the reports are shortly presented in 3.1. The two reports are two of the most recent documents concerning circular economy in the Danish construction industry and therefore used a source of data in the analysis to explore the potential future of circular economy in the industry. Both reports include a list of barriers to circular economy and were developed through a process of workshops and discussions involving numerous stakeholders in the Danish construction industry.

The Roadmap for circular construction was published by Realdania (Realdania, 2023b), one of the frontrunning investors in circular construction. The Action tank's report was developed under the guidance of DI Construction (Handletank for bæredygtighed, 2023), representing the interest of its members. Both reports claim to be representative of the Danish construction industry and are used in this report due to the potential influence the reports and involved stakeholders can have on the development of circular economy in the industry.

6.2 Data collection

Empirical data was collected through semi-structured interviews with the selected interviewees, and the method of data collection is elaborated in the following.

6.2.1 Semi-structured interviews

Studies on barriers to circular economy seem to rely on literature reviews, interviews, and surveys with a seemingly limited spectrum. While interviews and surveys can highlight specific challenges regarding the implementation of circular principles, the questions used to guide the interviews seem to be focused on what barriers the interviewees are experiencing (see 4.2.1), leading us to believe that the barriers should be explored more broadly. In this thesis, the primary data collection method is interviews, and the exploratory approach is used by having a relatively simple and short interview guide but allowing for informal conversation and discussion between us and the interviewees. Interviewees were encouraged to drift away from questions in the interview guide if any themes or points seemed important to them or relevant to elaborate.

Drawing on the limits of circular economic system (see 4.2), the chosen lenses of the PEA framework (see 5.3) were used to inspire the interview guides. As discussed earlier, the barriers to circular economy might be more nuanced and mutually interactive presenting themselves as a set of established linear rules (see 4.2) and are a consequence of different ideologies, values and influence dynamics. To cover the set of rules that circular economy is navigating, the interview questions covered topics such as definition (or the lack thereof) of circular economy, collaboration with other stakeholders, barriers that are the most pressing, processes for legislation and contracts, and responsibilities. An example of an interview guide is in Appendix 11.

All interviews were conducted as semi-structured and conversational in style. Interview guides ensured the interviews fulfilled their purpose while allowing the interviewees to speak beyond the prepared questions. All interviews lasted about one hour, depending on the time made available by the interviewee. At two of the interviews, additional time was allocated to observe the production or processes taking place in the company. These, however, have proven not to be relevant. Interviews were conducted in Danish, and transcriptions were made to enable coding, also in Danish. For reference, interview notes in English can be found in the appendices 1 – 10.

All interviewees were asked whether they wanted to stay anonymous in our thesis, which neither of the interviews found necessary. At potentially controversial opinions, interviewees asked not to be cited. Some of those statements are important for our analysis, in which case we specify that the concerned interviewee wishes to stay anonymous.

6.3 Analytical approach

This section introduces the analytical approach of the thesis, which consists of three analyses and a discussion, all contributing to answering the thesis's research question. Each analytical part is presented in the following subsections.

6.3.1 First analysis: Stakeholders in the Danish construction industry

The first stage in the PEA framework is to identify institutions and actors within the investigated industry (Moncrieffe & Luttrell, 2005). Therefore, the initial analytical part of this thesis involves mapping the stakeholders in the Danish construction industry. The focus of this mapping is to examine their roles and their relevance to the circular economy, aiming to answer the question: *Who are the stakeholders in the Danish construction industry and what relevance does their role have for circular economy?*

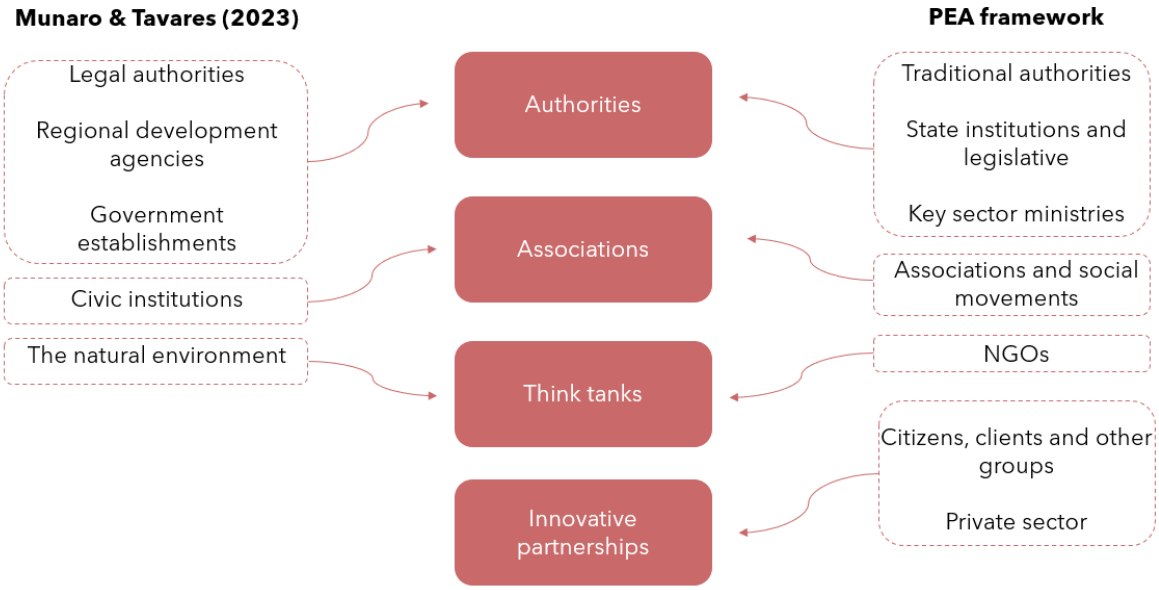

Figure 1: Relevant stakeholder groups from both document were chosen, compared and combined into four external stakeholder groups relevant to this thesis.

Stakeholders are divided into internal and external stakeholders. External stakeholders are defined as those not directly involved in a construction project's value chain but can influence the construction industry (Munaro & Tavares, 2023) and therefore challenging to delimit. When mapping the external stakeholders, inspiration is drawn from the PEA framework (see 5.3). PEA framework is not developed for a specific industry, and we supplement the framework with academic literature on the construction industry. The literature review by Munaro & Tavares (2023) was found useful in this regard. Figure 1 shows how we combined external stakeholders from the construction industry-specific literature with categories from the PEA framework to construct relevant external stakeholder groups: authorities, associations, think tanks and innovative partnerships.

Internal stakeholders are defined as those directly involved in a construction project's value chain (Munaro & Tavares, 2023). To map the internal stakeholders, inspiration is drawn from the stages in the construction value chain (One Planet, 2020), presented in Figure 2. The figure is a generalized and simplified model, showing eight stages of a construction value chain. The linearity of the figure

might suggest a straightforward process when one stage begins before another begins, but this is far from reality. In this thesis, some stages are combined. Financing stage and Planning and design stage are combined as the two initial stages of a construction project, where key decisions are made. Construction materials stage and Logistics stage are also combined, since material and product procurement and their distribution are tightly connected (see 6.3.1).

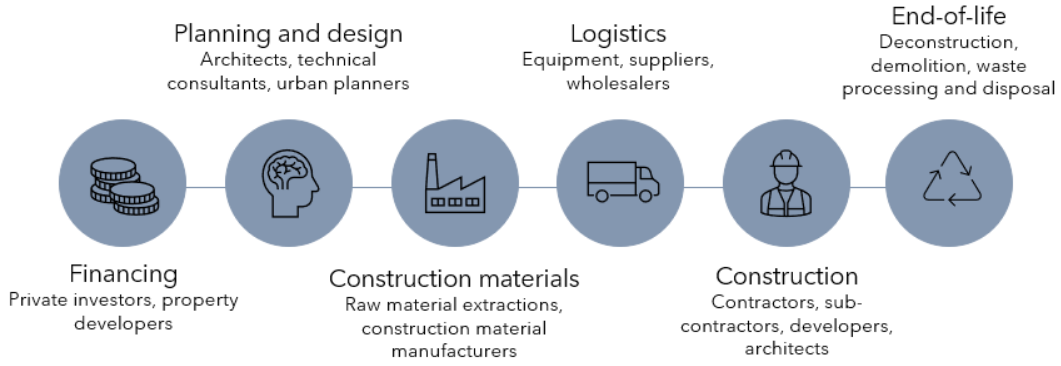

Figure 2: Stages in the construction value chain (One Planet, 2020).

In the analysis, we first present the general role of each stakeholder group along with the associated interviewed stakeholder. This is followed by a brief discussion of the stakeholder's role and current engagement with the circular economy, speculating on their relevance to the circular economy within the industry. The stakeholder mapping concludes with a discussion on how the stakeholders' roles, relevance, and positioning in the value chain can influence the development of the circular economy in the Danish construction industry.

The mapping of the stakeholders serves as a ground layer for the rest of the thesis: in the second analysis, to explore how the stakeholders' relevance and influence impact the trajectory of circular economy, and in the third analysis, to explore whether and how the barriers are affected by the role and relevance of the stakeholders.

6.3.2 Second analysis: Approaches to circular economy

Stakeholders' approach to circular economy is explored as the second analytical part, which aims to answer the question: *How does the stakeholders' influence narrate the future development of circular principles when considering their approaches to circular economy?* To do this, interviews have been coded according to high-level and low-level circularity, as presented in section 3.2.1. Furthermore, stakeholders' strategic approach to circular economy is also investigated and therefore coded for.

Table 5: Coding words and search strategy for the second analysis.

Second analysis: Approaches to circular economy			
Coding word	Strategic approach	Low-level circular economy	High-level circular economy
Searching for	Any mention of strategic approach to circular economy and/or importance of strategy in general, including but not limited to references to legislative targets.	Recycling, demolition, incineration, waste.	Reuse, renovation, transformation, long life-cycle, maintenance.

In this analysis, the distinction between internal and external stakeholders is maintained, because internal stakeholders can directly incorporate circular strategies into their processes and operations, whereas external stakeholders only can influence stakeholders in the value chain to act differently. Therefore, first part of the analyses focuses on internal stakeholders' approaches to circular principles in practice. Second part includes both internal and external stakeholders and examines their strategic approaches to circular economy.

The results of this chapter are used in the third analysis as part of the barriers for circular economy or to find which barriers might be more difficult to overcome.

6.3.3 Third analysis: Barriers to circular economy

In this analysis, barriers to circular economy are explored, followed by identification of underlying reasons for barriers based on three lenses of political economy. The analysis aims to answer the question: *Which underlying reasons for the barriers to circular economy in the Danish construction industry can be identified when viewed through chosen PEA lenses?*

Barriers to circular economy are found both through the interviews and in two key publications (see 6.1.2). The focus in the analysis is to explore the most prevailing barriers among the stakeholders and where there are conflicting or opposite opinions regarding a barrier. Interviews are coded for based on the coding words and search strategy in Table 6 below.

Table 6: Coding words and search strategy to the third analysis.

Third analysis: Barriers to circular economy and underlying reasons				
Coding word	Cultural barrier	Regulatory barrier	Market barrier	Technological barrier
Searching for	Responsibility, competencies, linear, habits, organizational, ambitions, collaboration, communication and more	Policy, legislation, regulations, authorities, EU, regulatory requirements, and more	Supply, demand, efficiency, productivity, commercial, market, price, and more	Data, materials, tools, risks, procedures, material properties, logistics

All barriers are categorized based on Kirchherr et al. (2018). The categories include cultural, regulatory, market and technological barriers. Cultural barriers involve lacking awareness and/or willingness to engage with circular economy, regulatory barriers involve lacking policies in support of circular economy, market barriers involve lacking economic viability of circular business models, and technological barriers involve lacking (proven) technologies to implement circular economy. The four categories are interrelated, and interactions among barriers in the different categories can therefore result in a chain reaction (Kirchherr et al., 2018). Interviews are coded based on the four categories. The barriers are then analysed and discussed, where experiences and opinions of the interviewed stakeholders and several Danish publications are deployed. First, we engage with regulatory barriers, followed by market barriers. Cultural barriers emerge throughout the analysis, making appearance already in the analysis of the approaches to circular economy. Technological barriers are in general easier to deal with and often a consequence of other barriers, either cultural, regulatory or market, which are more complex to solve (Wood & Gidado, 2008). Additionally, technical barriers do not emerge as core barriers (Kirchherr et al., 2018). Therefore, we don't engage with technical barriers on the same level as other barriers but in combination with cultural barriers to find potential interactions.

After analysing the barriers, both second and third analysis is coded to extract underlying reasons for the barriers. When coding the analyses, we are reading between the lines, meaning that we aim to extract underlying reasons that might not appear explicitly. Underlying reasons are grouped if similar ones have been identified. After coding, the underlying reasons are divided into three lenses of political economy from the PEA framework. The lenses include 1) change processes involving trends in policymaking and reasons, 2) power relations involving the effect of power relations on the policy processes and distortion of policy implementation, and 3) ideologies, values and perceptions involving conflicts and correspondence in ideologies and values.

7 Stakeholders in the Danish construction industry

In this analysis, stakeholders in the Danish construction industry are identified and explored, which is the first step in the PEA framework. The chapter answers the question: *Who are the stakeholders in the Danish construction industry and what relevance does their role have for circular economy?* The stakeholders are in this thesis divided into external, i.e. those that can influence the construction industry, and internal, i.e. those that are directly involved in a construction project's value chain. First, external stakeholders and their role in the industry as well as their relevance for circular economy are mapped and explained, followed by the mapping of internal stakeholders and their role and relevance. The last section in this chapter, a summary of the stakeholders, brings attention to the stakeholders' influence on circular economy.

7.1 External stakeholders

External stakeholders in the Danish construction industry are many and difficult to delimit. To condense the many stakeholders, the following groups were chosen for this thesis (see 5.3): 1) authorities, 2) associations, 3) think tanks, and 4) innovative partnerships. Besides their role and relevance, their possible influence on circular economy and the industry is explored.

7.1.1 Authorities

The Danish construction industry operates under a regulatory framework that encompasses the EU, national, and municipal levels. Given that Danish legislation must align with EU directives, this section will concentrate on the role of Danish authorities. The Energy Performance of Buildings Directive mandates stringent energy efficiency standards for buildings, requiring Denmark to integrate these standards into its national building codes. The Waste Framework Directive and the Circular Economy Action Plan emphasize waste reduction, recycling, and sustainable resource use (COM(2020) 98 final, 2020; European Commission, n.d.b), necessitating corresponding adjustments in Danish waste management regulations.

At national level, regulation of the construction industry is currently divided among various ministries. The Ministry of Social Affairs and Housing is central, as this ministry is responsible for The Building Act and The Building Regulations. The legislation involves ensuring safe and healthy buildings and construction processes through defining the framework for the Building Regulations (LBK nr 1178 af 23/09/2016, 2016), where technical requirements and standards are specified, including the requirements regarding climate impacts of new construction from January 2023 (BEK nr 1673 af 11/12/2023, 2023). These have recently been reviewed and updated due to the pressure from the construction industry. The new agreement on the GHG emission limits differentiates between building types, e.g. single-family houses, apartment buildings and office buildings, and the GHG emission limits are mandatory for all new construction (Social-, Bolig- og Ældreministeriets, 2024a). This ministry is also the authority behind the National strategy for sustainable construction, where attention is directed towards circular economy in two out of five focus areas, such as reduction of waste materials on construction sites, safe and healthy reuse of construction elements, and more focus on renovation rather than demolition (Social- og Boligstyrelsen, 2021).

Municipalities serve as building authorities and handle building permits following the Building Regulations. However, they can establish different rules through local plans. For example, local plans often

require building foundations to be made of concrete, a resource- and emission-heavy material, which hinders the use of innovative methods that require fewer resources and are less polluting (Beck, 2022). Additionally, municipalities function as developers for new construction or renovation of buildings. In this context, they can enforce specific rules and requirements regarding circular economy that construction companies must comply with. For example, the City of Copenhagen has developed a handbook with circular requirements for the municipality's construction projects. The handbook specifies that all new construction in the municipality must be certified with the environmental certification system DGNB and lists recycled materials that the municipality prioritizes (Københavns Kommune, 2022).

National and municipal authorities play a driving role in the construction industry, positioning them as key stakeholders in the implementation of circular economy principles within the industry (Realdania, 2023b). By establishing appropriate direction and eliminating legislative barriers, these authorities can facilitate the transition towards a circular economy. This can include updating building regulations to permit the use of innovative materials and construction methods. Additionally, when authorities act as developers, they have the opportunity to prioritize circular strategies in their projects, thereby setting exemplary standards for private developers to follow.

7.1.2 Associations

The Danish construction industry consists of different business and industry associations. One of the biggest associations is DI Construction (Appendix 2), which is a part of Danish Industries. DI Construction represents around 6.700 companies across the construction value chain. Their primary purpose is to represent the interests of their members and promote positive development for the industry. This involves participating in the political debate at all levels, from local to national and also the EU level, to ensure that legislation and policies support the needs and interests of businesses in the construction industry. They serve as a spokesperson for the industry, for example, by presenting viewpoints and proposals to politicians and decision-makers. They also work to ensure good market conditions for their members' products and services (DI Byggeri, n.d.). Participation in political debates and contribution to the relevance of the legislation and policies is supported by DI Construction's analysis of the industry and market. To promote sustainable development of the construction industry, DI Construction established the Construction industry's action tank for sustainability. The Action tank published a report in 2023 with recommendations for, among other, circular economy in the construction industry (Handletank for bæredygtighed, 2023). The report is developed in collaboration with different representatives from the industry's value chain such as developers, contractors, consultants etc. This report is one of the frequently used publications in this thesis (see 6.1.2).

Given its representation of a substantial portion of Danish construction companies, DI Construction might hold significant influence over the formulation and regulation of new industry legislation, thereby shaping the sector's progress towards a circular economy. Consequently, DI Construction's approach to circular economy principles and their positions on related issues can direct legislative initiatives and impact the actions and perspectives of its members.

7.1.3 Think tanks

A think tank is an organization conducting research and advocating in areas such as social policy, political strategy, science, or technology (Pop, 2012). Concito, Denmark's green think tank, aims to

provide scientific and evidence-based analyses and information and facilitates the translation of this knowledge into climate action. Their work is organized into specific program areas, including the construction industry (Concito, n.d.). Concito operates with political independence, serving the entire political spectrum without favoring any particular political parties. Instead, it offers knowledge and data to guide politicians and other decision-makers in formulating new regulations and specific requirements. For instance, Concito has published a climate analysis of the construction, offering recommendations for reducing GHG emissions in the industry (Laursen et al., 2023). Furthermore, Concito adopts an international perspective by exploring how Danish experiences can be scaled internationally, and how Denmark can draw inspiration from other countries (Appendix 5).

Although Concito does not have the authority to make legislative decisions and thus cannot directly influence the circular transition, its high credibility and recognition within society and the political system enable it to indirectly shape the circular agenda.

7.1.4 Innovative partnerships

Many sources underscore the importance of collaboration and communication across the construction value chain, e.g. Kirchherr et al., 2018; Leising et al., 2018; Realdania, 2023b. Circue (Appendix 4), a rather new partnership, has prioritized this aspect since its establishment. In collaboration with a diverse group of stakeholders in the Danish construction industry, Circue has developed prototypes of a digital tool to promote circular economy along the construction project value chain. These prototypes are meant to become a digital platform in early 2025 with tools that can help decision-making and add value for stakeholders in the construction industry. The tools involve, for example, an AI-supported resource screening that can be used for building audits, a circular scenario evaluation that can guide decisions for refurbishment, transformation, or demolition, and an online marketplace for exchange of secondary materials. (Source Circue, n.d.)

Innovative partnerships, such as Circue, can help the construction industry and stakeholders within it try alternative methods and solutions that contribute to a circular economy by introducing, testing, and promoting them. The size of and resources put in a partnership as well as support from the outside, can determine the level of influence they might have in the industry.

7.2 Internal stakeholders

Construction projects are often referred to as being complex. One reason is the large number of interdependent and interacting parts in the value chain, including numerous stakeholders, developers, and investors to contractors, subcontractors, and different aspects of a project, such as contracts and time scheduling. The stakeholders and the activities related to different project aspects operate interdependently where e.g. activities of one stakeholder depends on another stakeholder's tasks (Wood & Gidado, 2008). Additionally, there can be a significant variation in the level of knowledge about circular economy within each part of the value chain and across different stakeholders (Realdania, 2023b). The construction industry is also described as one of the most dynamic, risky, and challenging businesses with demanding time constraints, which leaves limited room for innovative ideas and new approaches. The complexity of the construction industry and its value chain is important to have in mind, as this can hinder more circular initiatives (Wood & Gidado). Some stakeholders are involved throughout the entire construction project, while others are only involved for a shorter period. Additionally, some stakeholders may hold multiple roles and positions, depending on

the specific construction project. The following section outlines the stages in a construction project's value chain (see 6.3.1), detailing the roles and relevance of stakeholders in each phase of the project.

7.2.1 Financing & Planning and design

The financing stage is the first stage in the construction value chain, as this is the stage where investors or developers initiate a construction project. One of the largest investment groups in Denmark is the pension companies, and PensionDanmark (Appendix 6) is one of the largest pension companies in Denmark. They invest in and develop both commercial properties, residential properties, and new urban areas, where they collaborate with, among others, municipalities. When investors, such as PensionDanmark, set demands regarding reused or recycled content in their constructions, they push the market to meet those requirements e.g. manufacturers are incentivized to supply new types of construction materials, while architects and contractors align their offerings in this direction because those who can meet the requirements are the ones getting the job (Sørensen & Oberender, 2019). This is recognised in PensionDanmark, who have developed a program for sustainable initiatives that includes circular strategies. The program is known among stakeholders in the construction industry, and as a result, architects and contractors adapt their practices to align the program (Appendix 6).

KAB (Appendix 1) is Denmark's largest administrative organization for non-profit housing. KAB's role in this phase is somewhat distinctive. As an administrative organization, KAB is owned by its members, non-profit housing organizations that develop new constructions and renovate existing buildings. Consequently, KAB is neither an investor nor a developer; instead, it provides administrative support, guidance, and counselling to its members(KAB, n.d., Appendix 1). This role constrains KAB's ability to prioritize circular principles in non-profit housing construction projects. Decisions regarding circular economy initiatives are made democratically through consensus among KAB's members (Appendix 1).

The planning and design stage is where architects and other consultants detail, calculate, and specify construction projects, where decision such as choice of materials and construction techniques are made (One Planet, 2020). Investors and developers play a driving role in the circular transition by setting the right requirements and expectations in a construction project, but how consultants in the planning and design stage tackle these requirements and which choices they make influence the activity along the rest of the value chain (One Planet, 2020). Implementation of circular strategies is therefore dependent on the coordination between the two stages: the financing stage setting the circular requirements and the planning and design stage having the competences and skills to meet the requirements and design for circular construction e.g. by considering material use or design for disassembly.

7.2.2 Construction materials & Logistics

The extraction of materials and the production of construction materials and elements is the first stage in the value chain where natural resources are used (Figure 2). Construction materials and products encompass a wide variety, ranging from large elements such as walls and foundations to smaller elements like plumbing and electrical systems. Concrete represents the largest fraction of construction and demolition waste (Miljøstyrelsen, 2022), thus attracting significant attention in discussions about problematic construction materials (Belaïd, 2022). However, smaller elements can also be resource-intensive, e.g. those made of plastic and metal (UN Environment Programme, 2022).

One of the dominating non-renewable materials in the construction industry is plastic (Source UN Environment Programme, 2023). At Letbek, recycled plastic serves as the primary resource in the production of plastic products for various applications, including the construction industry (Appendix 9). Recently, Letbek was acquired by a waste management company, simplifying and optimizing the supply of recycled plastic. The acquisition and Letbek's own activities have resulted in competitiveness with raw materials in terms of both cost and quality, which are critical factors in determining the selection of construction materials for projects (Appendix 9).

Construction materials and elements are distributed either by the manufacturer or wholesalers, who act as intermediaries between manufacturers and construction companies. Letbek's largest costumer group are wholesale companies. AO as a wholesaler (Appendix 7) is involved in take-back schemes with some of the manufacturers, where AO's customers can deliver construction elements at the end of their life. These elements are then collected by the manufacturers and used as secondary material in production of new elements. AO is also developing digital solutions to help its customers choose products with the least negative impact.

Manufacturers play a crucial role in selecting the resources for their materials and products, opting for either raw or secondary resources. Moreover, manufacturers can design and develop more circular products, thereby expanding the supply of circular products in the market and can, with established collaborations, encourage the circularity of materials and construction elements. Wholesale companies can influence their customers in their choice of products and can function as a link between manufacturers and construction companies.

7.2.3 Construction

The construction stage involves the actual construction or renovation of buildings and consists of stakeholders such as contractors and sub-contractors. Arpe & Kjeldsholm and FLD are two construction companies, that are hired either as contractors or sub-contractors by developers or investors in construction projects. Arpe & Kjeldsholm (Appendix 8) works primarily with larger construction projects as the head contractor, while FLD (Appendix 10) specializes in plumbing and electrical installations. Furthermore, FLD focuses on renovation projects of existing constructions, and prioritize projects where sustainability and environmental aspects are valued in the tenders.

Construction companies are required to meet demands and expectations from the developer or investor, which are formulated in a project contract between the two stakeholder groups (see 6.2.1). Collaboration levels between investors, developers and contractors varies. Sometimes, investors and developers are open to a dialog about circular possibilities and changes in the requirements, while other times contractors cannot influence the content of a construction project (Appendix 8).

Construction companies generally work with low-profit margins, i.e. keeping costs down is highly important. This can limit the possibility of using more sustainable materials and circular practices if this is not prioritised by the developer of the project. At the same time, construction companies must comply with complex building codes, making the realisation of circular ideas and visions set in initial project design difficult. (Appendix 8)

7.2.4 End-of-life

Stakeholders relevant in this stage are those overseeing demolition of a building and those managing the construction and demolition waste. Norrecco (Appendix 3) is a one of the biggest construction and demolition waste management companies in Denmark. Norrecco plays a crucial role in the end-of-life stage of the construction industry, which involves managing the waste generated from new constructions, renovations, and demolitions. Norrecco focuses significantly on recycling waste materials, including sorting and processing materials such as concrete and wood. Waste that can't be recycled undergoes incineration or disposal.

Demolition companies and waste management companies are in the future expected to have high relevance for circular economy in the Danish construction industry. With the coming mandatory selective demolition, the focus is on careful demolition of buildings to promote circularity of construction materials and elements (LOV nr 323 af 02/04/2024, 2024, p. 323).

7.3 Summary of stakeholder influence on circular economy

Construction projects are known for their complexity due to the interdependency of project's aspects and involved stakeholders, each with their role and available resources. Additionally, numerous external stakeholders can add to the complexity, advocating for different values and interests.

National and municipal authorities hold significant influence through legislation. For example, the Building Regulations, where focus is on ensuring the safety of a building's occupants, are mandatory at the national level and impact construction practices. The stakeholders in the Danish construction industry must comply with these regulations, often limiting opportunities for circular practices. However, municipal authorities have the capacity to promote circular economy by loosening the requirements of local plans. As developers, municipalities can also act as a frontrunner by adopting ambitious circular economy strategies.

Industry associations, such as DI Construction, advocate for the interests of the industry and engage in political dialog to influence the formulation of regulations and other policies to ensure a regulatory landscape that supports the activities of their members. Regulations and other policies can also be influenced by think tanks like Concito, by providing evidence-based analysis and offering recommendations for climate action grounded in objective approaches. While Concito is recognized as a credible and respected organization with an objective stance, DI Construction, equally respected, might have a more biased approach to safeguard the interests of its members. This divergence in perspectives can lead to power dynamics if both stakeholders are involved in negotiations. Due to their role and associated activities, these two stakeholders can also influence the knowledge, interest, and actions of the internal stakeholders.

Practices in the Danish construction industry can be shaped by stakeholders like Circue, an innovative partnership developing digital platform to facilitate collaboration for circular economy and promote alternative approaches to construction projects. The influence of Circue depends on external support. Although Circue appears to have backing from some of the most influential stakeholders in the industry, its widespread influence is currently difficult to assess.

Two of the stages of a construction project that Circue hopes to influence are financing and planning and design. In these two stages, investors and developers initiate a construction project and specify

the details in collaboration with architects and engineers. Some investors, like PensionDanmark, are considered frontrunners in circular construction practices and engage with circular strategies from the get-go. Other investors and developers have less interest in circular economy and might only be influenced in later stages, where the key characteristics of a building have already been agreed on. Other stakeholders in these two stages, like KAB, have very limited influence on circular economy, due to the democratic decision-making processes among their members.

The decisions set in the first two stages influence the rest of a construction project's value chain. Requirements for circular products can push manufacturers to develop and supply these products. The type and quantity of needed materials and products can influence the supply chain activities and logistics both between the manufacturer, wholesaler and construction sites. The choice of materials and building techniques can influence the end-of-life of a building, where composite materials and traditional techniques complicate selective demolition and add to high waste amounts.

Overall, the influence dynamics involve a complex network of stakeholders, where each party's actions and decisions have a domino effect throughout the construction value chain. For instance, some developers and investors are actively engaging with circular economy from the early stages of projects with a wide range of circular options. Other stakeholders may adopt these practices only later, after key decisions have already been made and possibilities for circular economy are limited. This disparity highlights the importance of early commitment to circular principles to influence the entire value chain, from material selection to construction techniques, ultimately impacting resource management at the end of a building's lifecycle. In the following chapter, we analyze how different stakeholders approach circular economy, including the influence of authorities, industry associations, and think tanks, which can offer insight into the development of circular economy in the Danish construction industry.

8 Approaches to circular economy

This analysis explores the understanding of CE among the interviewed stakeholders in the construction industry. Academic research emphasizes the challenges of numerous understandings of circular economy, also apparent in the construction industry. Through the interviews with stakeholders, we detected a general agreement that the Danish construction industry is also challenged by the missing agreement on what circular economy is, resulting in different approaches, different ambition levels and reliance on the EU legislation. To understand the impact of the stakeholders' approaches and their influence, we aim to answer: How does the stakeholders' influence narrate the future development of circular principles when considering their approaches to circular economy? We begin the chapter by mapping how the interviewed internal stakeholders apply circular principles in their operations, where low-level and high-level circular activities are explored, to identify possible prevalence of one level. During the interviews we detected that stakeholders' approaches to circular economy also differ – from relying on legislation to developing strategic approach. This we explore in the second section of this chapter. Throughout the chapter we pay attention to the stakeholders' positioning in the value chain and their role and relevance to finish the chapter by reflecting over how the stakeholders' influence can affect the development of circular economy in the Danish construction industry.

8.1 Circular economy in practice

This section focuses on internal stakeholders as they apply circular economy in practice. The stakeholders' engagement with low-level circular strategies is explored first, followed by their engagement with the high-level circular economy. Throughout, the attention is on how the activities and interests of stakeholders influence other stakeholders and their application of circular economy.

8.1.1 Demolition and recycling

Among the interviewed internal stakeholders there is generally high focus on waste sorting, recycling, and use of recycled materials (Appendix 1, 3, 8, 9 & 10). A supply of materials with high recycling potential is crucial for Norrecco, waste management company, that collects and processes waste generated during new construction, renovation, and demolition of buildings (Source Norrecco, n.d.). Construction materials often contain substances harmful to the environment, challenging the material recovery of construction and demolition waste (CDW). The protection of the local environment and groundwater is thoroughly regulated in Denmark, and CDW containing contaminants must be disposed of safely and is often transported to other countries (Appendix 3). Even though some CDW is currently only appropriate for disposal, Norrecco partakes in several development projects to ensure high recycling rates1 of CDW (Appendix 3). For example, a partnership to increase the rate of recycled gypsum in the production of new gypsum plates (one of the most used materials in construction) was established with the producers of the plates and the biggest CDW management company in Denmark (Reconor, n.d.). Another important factor in achieving high recycling rates is demolition (Appendix 3), where resource mapping is one of the first steps to ensure correct sorting of the demolished material (Miljøstyrelsen, 2018). According to one interviewee, demolition companies therefore play an important role: if they don't do their job properly, CDW cannot be sorted and recycled (Appendix 3). However, demolition guidelines developed by the Danish Ministry of Environment point out developers as the most important players. The first step to resource mapping is a clarification of the

developer's wishes and ambitions (Miljøstyrelsen 2018), which puts the responsibility into the developer's hands. The resource mapping guidelines put the developer's time- and economy expectations before the expectations about circular possibilities. When lack of time and financial resources already are challenging the implementation of circular economy, the guidelines from authorities seemingly prioritizing these two aspects can further discourage stakeholders from high-circular economy. Værdibyg, a Danish initiative for developing construction processes, elaborates on the expectations and considerations of the developer, where the materials appropriate for reuse can be reused either in the developer's own construction projects or handed over to other developers or suppliers. Sometimes, the developer doesn't have a specific use for the materials in mind and only wishes for materials to be accessible to anyone (Værdibyg, 2020). Recycling of materials can therefore suddenly seem like the easiest, fastest, and cheapest option. This is supported by Norrecco's belief that the upcoming legislation on selective demolition won't affect their revenue. This suggests a lack of confidence in selective demolition promoting high-level circular economy, reinforcing the infrastructure for low-level circular economy.

When involved in the early stages of a construction project, where an existing building should be demolished, Arpe & Kjeldsholm consults developers on how to demolish to ensure high recyclability of the materials. To do so, they established collaborations with manufacturers or other stakeholders who can recycle specific materials instead of all materials being collected by a CDW management company like Norrecco (Appendix 8). With its established position as a CDW management company, Norrecco's revenue can be affected by Arpe & Kjeldsholm's approach, where the company searches for new collaborations, to disperse the management of demolition waste among different stakeholders. This can affect market dynamics and create tensions among the concerned stakeholders. However, the demolition for high recyclability depends on the physical organization of the construction site and the availability of other resources – time and economy – which are, as experienced by the interviewee, normally the most important factor guiding the developer's decisions (Appendix 8), suggesting that Norrecco and other CDW management companies are not yet threatened by the ambitions of some stakeholders. One interviewee also mentions a tendency of resource mapping for waste as another challenge of demolition practices (Appendix 4). While this can be understood in different ways, the circular ambitions of the interviewee indicate a concern of continuous focus on mapping resources for recycling instead of reuse. This tendency further secures the position and influence of CDW management companies and recycling infrastructure.

Other interviewed internal stakeholders also engage in waste sorting and recycling practices. FLD sets requirements for waste sorting at their construction sites that all subcontractors must comply with. The interviewee expresses challenges related to the subcontractors' different awareness, knowledge and resource levels and to help them, FLD provides education on why and how to sort waste correctly (Appendix 10) The interviewed wholesaler, AO, has a target for the reduction of unrecyclable waste: in 2030, only 10 % of AO's waste should be incinerated or disposed of, which is in line with the EU taxonomy's criteria, where at least 90 % of CDW should be prepared for reuse or recycling for the activity to be considered having a substantial contribution to circular economy (C(2023)3851 ANNEX 2, 2023). To reach the target, AO has established a detailed waste sorting system at all its locations and is continuously educating its employees on correct waste sorting. To identify waste sorting challenges and appropriate solutions, AO also facilitates employee workshops (Appendix 7). Both, AO and FLD are a part of take-back programs, where customers and subcontractors can deliver specific

products at the end of their lifetime. These are then collected by the manufacturer of the product for further treatment. In most cases, the manufacturer has established an infrastructure for recycling the material and incorporating the recycling content into the new products (Appendix 7 & 10) AO and FLD's awareness of importance of internal and external education suggests that both companies are willing to be proactive in collaboration. However, the collaboration is currently limited, which might be because of their positioning in the value chain, where they don't have a lot of influence on circular economy in a construction project.

Letbek, a manufacturer of plastic products for the construction industry, also relies on correct waste sorting, as their activities and reaching of targets depend on recycled materials. Currently, about 70 % of procured material is secondary material, but Letbek aims to increase that number, where in the future 90 % of the procured material will be recycled plastic. The remaining 10 % of their material procurement would constitute of binding agents and other materials that cannot be recycled (Appendix 9). The interviewee expressed that the company is often overlooked by other stakeholders in the construction industry, limiting their opportunities to influence circularity in the industry. With the recent acquisition of Letbek by a Nordic waste management company (see 7), Letbek gets easier access to recycled plastic and a possibility of creating new relationships and collaborations, which can create new business opportunities for Letbek.

Many of the interviewed stakeholders mentioned the EU taxonomy shaping their waste management activities (Appendix 3, 6 & 8). This can explain the focus on recycling, as these legislations traditionally have focused on recycling and other materials recovery. While the EU waste targets also include possibilities for reuse, the vague formulation of legislation leaves room for reaching the targets with any of the three principles (C(2023)3851 ANNEX 2, 2023). With a well-established recycling infrastructure, including technology and developed practices, combined with the time and financial constraints of construction projects, it is possible to assume that reuse is the least attractive option for the relevant stakeholders.

8.1.2 Renovation and reuse

Of the interviewed stakeholders, some expressed increased focus on high-level circular economy. A stakeholder, that can significantly influence a construction project's value chain, PensionDenmark is an investor in and developer of construction projects (see 7). As mentioned previously, developers and investors play a significant role in promoting circular economy, as key decisions are met in the starting stages of a project. To apply circular economy from the get-go, PensionDenmark developed a Program for sustainable initiatives, where the minimum requirements regarding sustainability and circular economy are specified. All construction projects that PensionDenmark is involved in must comply at least with these requirements. The program is based on the DGNB certification system, which is one of the requirements, but other areas related to sustainability were added to accelerate the reduction of the negative impact. One of the added areas is circular economy. The requirements in the program advocate for the preservation of the buildings rather than demolition. Each existing building must be evaluated and if the building can only be demolished, the stakeholder responsible for the demolition must resource map the building prioritizing reuse possibilities and mentions local civil society as a potential stakeholder that could make use of the building's elements. The first stages of a construction project affect the choice of materials and their procurement. Here, PensionDenmark

expresses preference for reused materials and materials with high reuse and recycling potential. Furthermore, these stages also impact end-of-life of a building, where PensionDenmark requires design for disassembly to promote reuse of the elements in other contexts. Prevention of waste during the construction process is also high on the developer's list of priorities. In the evaluation of the above potential, relevant experts must be involved in the process. Here, construction company Arpe & Kjeldsholm can come in play; whenever possible, they try to influence developers to renovate or transform or resource map for both reuse and recycling (Appendix 8). However, depending on the interests, influence and established collaborations of the relevant experts, the PensionDenmark's requirements might have varying effects.

Another interviewed stakeholder engaging with the renovation of buildings is FLD. While FLD built its business model around the demand for renovation coming from the stakeholders, the company always avoids tenders with price as the only determining factor and only selects tenders with an environmental focus. The interviewee also mentioned that FLD encourages public authorities to include environmental aspects in their tenders (Appendix 10). Prevention of waste is also on FLD's radar: FLD organizes a yearly event where individuals can collect used or excess construction materials supplied by wholesalers and sub-contractors. The construction materials are free, and the project doesn't yield direct financial benefits but rather spreads awareness among individuals and can potentially strengthen the existing relationships between FLD and involved internal stakeholders. Unfortunately, FLD only sees reuse possibilities in individuals as reused construction elements lack the same qualities compared to new products (Appendix 10), which can encourage the focus on low-level circular economy discussed above.

8.2 Strategic approach to circular economy

A strategy is a plan that guides actions to achieve company's goals and supports decision-making, allocation of resources, and adaptation to change (Dixon, 2023). If circular economy is approached strategically, it can encourage different allocation of resources and identification of hidden opportunities. When supported with a vision, a strategic approach to circular economy can coordination among stakeholders and create guidance and orientation for a common goal in a construction project (Leising et al., 2018). Working with circular economy strategically can therefore be beneficial if stakeholders wish to strive for long-term and comprehensive improvement. As explored in the previous section, interviewed stakeholders work with circular economy in different ways. Furthermore, it also differs from the stakeholders whether they have a strategic approach to address circular economy. While previous section focuses on internal stakeholders, this section also includes external stakeholders, as their strategic approach of circular economy can influence how stakeholders in the value chain will operate and incorporate circular principles in the future.

8.2.1 Strategic approach of stakeholders in the construction value chain

For Norrecco and Letbek, recycling is the core of their businesses, and therefore developing methods and finding other ways to increase the quality and quantity of recycled materials are very much a part of their business strategy (Appendix 3 & 9). Since recycling currently seems to have a brighter future compared to reuse, developing a strategy with high-level circular economy might seem irrelevant and even unnecessary for these two stakeholders. For several other stakeholders in the value chain, the focus is similar – correct waste sorting for increased recycling rates. These stakeholders are primarily

optimizing these processes to comply with legislative requirements (see 8.1.1). Other stakeholders also work with elements of high-level circular economy, such as Arpe & Kjeldsholm trying to influence the developers toward renovation and reuse. Their efforts depend on the interests of stakeholders and commercial relevance for the company (Appendix 8) and don't seem to be a part of a comprehensive company-wide strategy. According to the interviewee, a strategic approach to circular economy in a construction company is not relevant due to current established practices regarding contracts and collaboration (Appendix 8).

On the contrary, one interviewee believes that flexibility is important for businesses to keep up with future trends and demands and highlights the importance of incorporating science and research in business decisions (Appendix 6). To accommodate this, PensionDenmark developed the program mentioned above, which is frequently adapted to incorporate the latest developments in the DGNB certification system and the EU taxonomy. Additionally, such an approach enables adaptation and development of the relevant competencies (Appendix 6). Considering the numerous ways in which the construction industry can be circular (see 4.1) and the many stakeholders with different roles and influences (see 7), the identification of relevant competencies can prove challenging. For some stakeholders, the relevant competencies might be technical regarding characteristics of novel construction materials or innovative disassembly methods. For other stakeholders, relevant competencies might cover organizational or project management competencies including knowledge about sustainability and circular economy. Another stakeholder similarly expresses the importance of a strategic approach. Even though low-level circular economy is currently the prevalent direction, mandatory EU legislation on environmental reporting revealed circular economy as one of the most pressing issues on AO (Appendix 7). According to the interviewee, most of the relevant stakeholders within and outside the company currently tackle circular economy in an uncontrolled and disorganized way. Therefore, AO considers circular economy not only as a concept that should be developed strategically within the company but with the support of strategic collaboration with AO's external stakeholders (Appendix 7). While these two stakeholders, PensionDenmark and AO, have similar mindset about strategic approach being crucial for company's existence and commercialization of circular economy, we observed a difference in their experiences regarding pressure. PensionDenmark believes that the program based on the latest development and knowledge is necessary to meet the pressure coming from their customers (Appendix 6), AO doesn't experience the pressure coming from either their customers or suppliers (Appendix 7).

8.2.2 Strategic approach of interviewed external stakeholders

External stakeholders differ from stakeholders in the value chain, as they cannot adopt circular principles in either production, construction, or resource management. However, external stakeholders' strategic approach to circular economy can matter as they can influence the actions of the stakeholders in the value chain. External stakeholders interviewed in this thesis have very different positions in the construction industry (see 7) and thereby different power and influence.

To strategically tackle sustainability in the Danish construction industry, DI Construction initiated Action tank for sustainable construction that in early 2024 published its first report (Handletank for bæredygtighed, 2023). The Action tank's goal is to create a common direction for the industry and considers circular economy as one of the areas that must be developed strategically. For that, the Action tank recommends developing an action plan for circular economy, that would build on the

government's Strategy for circular economy from 2018. DI Construction's primary goal is to ensure supportive environment for the flourishing of the businesses in the Danish construction industry through political dialog, the association must also ensure that political ambitions are realistic (see 7). Although the Action tank's strategic orientation might seem ambitious at first glance, the level of ambitions becomes questionable when the Action tank's recommendations become a part of political dialog. Furthermore, some of the members of DI Construction are some of the biggest players in the industry with strong influence (Appendix 4), which can steer the strategic direction of circular economy according to their own interests. This is expressed as a worry by one interviewee (who wishes to stay anonymous), who also underlines that the relevance of one's activities must align with the rest of the industry. This indicates that if the most influential stakeholders also dictate the strategic direction of the industry, other stakeholders will have to follow to stay relevant.

Compared to DI, Concito has an objective role with the main interest of advocating for climate action of society (see 7). Concito has previously focused on CO2 reductions through for instance highlighting energy efficiency or wood constructions. However, they aim to shift their focus towards circular economy. For instance, they are launching a new program directed at circular economy practices, aiming to draw on experiences from the Netherlands, which currently has a circularity percentage six times higher than Denmark (Appendix 5). This can suggest a stronger strategic approach to circular economy in the future. Additionally, in a publication from 2023, Concito identified seven focus areas to accelerate the construction industry's green transition, where one focus area is the importance of renovation over new construction. Within this focus area, they recommend implementing a requirement to compare the climate impact of demolition and new construction versus renovation and transformation before granting demolition permits, as the renovation will prove the least damaging to the climate and environment (Laursen et al., 2023).

In this context, Circue comes in play, as their strategic focus is to encourage developers and investors to avoid new construction and rather renovate or transform the existing buildings. While Circue acknowledges that their activities started as a development of an online platform for a material bank to upscale the reuse of buildings' elements, they soon learned that challenging developers' viewpoints to move the developers' choices toward high-level circular economy and conservation of buildings. Despite Circue being a relatively small company, they are mentioned in several publications and reports, such as Concito's foresight notes for circular economy in construction (Dyck-Madsen et al., 2022), which indicates recognition of their work's importance for the Danish construction industry. Like Concito, Circue sees great potential in making demolition permits contingent on calculations of the climate impacts compared to renovations, as this can highlight the environmental and economic benefits of renovations (Appendix 4).

Several strategic recommendations and activities of the external stakeholders seem to be aligned. For example, all of the mentioned external stakeholders, including the Action tank for sustainable reduction and Roadmap for circular construction (Handletank for bæredygtighed, 2023; Realdania, 2023b; Appendix 2, 4 & 5) agree on the importance of renovation and transformation to reduce the amount of new construction. Combined, these stakeholders can have an even bigger influence on the shaping of potential policies and regulations for circular economy in the construction industry. The new agreement on climate requirements includes a closer examination of the possibility to deny a permit for the demolition. If the mentioned stakeholders together advocate for this and can prove

the benefits of renovation compared to demolition, the government might be more prone to make denial of demolition a reality.

8.3 Predicting the trajectory for circular economy

Economic and time constraints seem to poses a significant barrier to high-level circular economy, as the established recycling infrastructure, supported by established practices surrounding waste management and influential CDW management companies like Norrecco, can appear more appealing to relevant stakeholders like demolition companies, as well as manufacturers of construction materials and products, such as Letbek, that can increase the amount of recycled materials in the production of new products.

Due to their positioning in the value chain, some stakeholders, despite their high ambitions and strategic thinking, currently have limited influence on circular economy in construction projects. These companies, e.g. AO and FLD, therefore focus on correct waste sorting to encourage more efficient recycling. AO is though aware that circular economy requires strategic approach and is planning to develop strategic collaborations to promote high-level circular economy. Similarly, PensionDenmark, believes in strategic approach to circular economy and has developed a program for sustainable initiatives, mandating the relevant stakeholder to integrate circular economy principles in PensionDenmark's construction projects. Due to their positioning in the value chain, their influence on circular economy can be rather significant. PensionDenmark enters construction projects in the initiating stages, where key decisions are made. Some stakeholders therefore don't approach circular economy strategically, as they believe the strategy for circular economy would have minimal effect, and focus on compliance with legislation, developers' requirements and immediate economic benefits. This concentration of influence can result in circular economy approaches that favor either established practices or the influential stakeholders' ideology.

External stakeholders, even though not directly involved in the value chain can significantly influence the adoption of circular economy in the Danish construction industry. One of the recommendations that all interviewed stakeholders agree on is the promotion of renovation and transformation instead of demolition and new construction. The agreement on a strategic direction of circular economy can amplify their collective influence in political dialog. On the other side, due to varied influence levels and differences in values and objectives, coordination between the external stakeholders regarding specific initiatives and necessary regulations might prove difficult. The influence of large industry players within DI Construction raises concerns about their potential to steer the agenda towards their interests, potentially lowering political ambitions or sidelining smaller stakeholders.

Overall, the trajectory of the circular economy in the Danish construction industry is characterized by a strong focus on recycling, supported by established infrastructures and regulatory frameworks like the EU taxonomy. There is a growing interest in reuse and renovation, particularly among large developers and there seems to be an alignment among various stakeholders on the importance of renovation and transformation. However, established recycling infrastructure and economic and time constraints pose significant challenges to achieving high-level circular economy. Without significant change, the shift toward high-level circular economy will remain gradual and face substantial practical obstacles. To further understand the possibilities for high-level circular economy, we analyze the barriers in the Danish construction industry.

9 Barriers to circular economy and underlying reasons

The previous chapter explored the circular principles prevalent in the Danish construction industry, and we find that the current prevalence of recycling and demolition practices combined with the influence of established stakeholders pose a threat to the development and implementation of high-level circular economy. This analysis investigates what else can hinder high-level circular economy and we aim to answer: *Which underlying reasons for the barriers to circular economy in the Danish construction industry can be identified when viewed through chosen PEA lenses?* The chapter begins with an overview of the barriers in the Danish construction industry. Then, the barriers from two publications central to this thesis are compared to those identified through the conducted interviews. This reveals the possible challenges of using the published barriers as a guide for defining necessary initiatives. The barriers identified through the interviews are then analyzed by comparing the experiences and opinions of the interviewed stakeholders and taking other sources, like Danish guidelines and policies, into account.

9.1 Overview of the barriers in the Danish construction industry

The two tables below summarize the barriers in the Danish construction industry. The first table (Table 7) shows the barriers from two key Danish publications (see 6.1.2) and the second table (Table 8) is a collection of barriers identified through the interviews. All barriers are divided into four categories by Kirchherr et al. (2023).

Tabel 7: Collection of barriers from two Danish publication, Roadmap for circular economy in the construction industry ('RM') and the report by the Action tank for sustainable construction ('AT').

Cultural	Regulatory	Market	Technological
The main part of the industry continues "business as usual" and has not yet adopted circular solutions. (RM) The processes and economy of the construction industry continue to be linear. (RM) The construction industry needs to nuance the value proposition. (RM) Conservative culture in the construction industry, where "used to" often dominates. (AT) Architects, engineers, contractors, and manufacturers lack knowledge and education about circular solutions. (AT)		Large-scale and commercialization of circular solutions is missing. (RM) Implementation of circular principles in new construction is lacking. (RM) There is a lack of financial incentives, e.g. renovation can often be more expensive than new construction, and recycled materials can be more expensive to use than new materials. (AT) There is a lack of infrastructure to handle reused or recycled materials. (AT) Lack of demand in the market and among customers. (AT)	Uncertainty about the quality of reused materials and hence the questions of risks. (AT)

Tabel 8: Summary of the barriers identified through the interviews. The barriers under respective categories follow an descending order.

Cultural	Regulatory	Market	Technological
Lack of initiative and different ambition levels Lack of competencies and resources Lack of communication and coordination along the value chain Complexity of responsibility and risks for new materials and methods Lack of internal communication about circular economy	(Realistic) political ambitions Obstructive legislation (for reuse) Lack of implementation Construction aspects diffused across many ministries.	Cheaper linear construction Lack of circular products Lack of standardized circular criteria for setting demands Municipal budgeting Lack of CE demonstration in mainstream projects	Inconsistent data Over-dimensioning Unknown risks when using new and circular materials and components with different properties. Challenging logistics at construction sites

Cultural barriers seem to be the least mentioned barriers in academic literature. In these studies, lack of appropriate technological solutions and slow entering to the market are mentioned as some of the technological barriers that hinder wide-spread circular economy (de Jesus & Mendonça, 2018). On the contrary, cultural barriers seem to be a bigger obstacle than technological, when experiences of business and policy-making stakeholders are considered (Kirchherr et al., 2018). Similarly, cultural and market barriers also seem to be the most pressing barriers to circular economy in the Danish construction industry. As an example, hesitant company culture, where circular economy is not integrated into company's vision and strategy (Kirchherr et al., 2018) is reminiscent of lack of initiative and different ambitions levels (Table 8), where the stakeholders in the Danish construction industry lack specific circular targets and strategies. Limited willingness to collaborate in the value chain is not identified as a pressing barrier (Kirchherr et al., 2018) but seems to be more important among the interviewed stakeholders. Even though the theorized barriers are a good starting point for understanding the hurdles in implementing circular economy, they are not context-specific, and the nuances of a barrier are lost. Among the stakeholders interviewed for this thesis, different viewpoints and experiences regarding initiative and ambitions have been noted. Therefore, we believe that understanding the barriers can equip relevant stakeholders with a new perspective and discussion points.

9.2 Barriers in Danish publications

The first observation of Table 7 shows an empty 'regulatory barriers' box; neither of the two publications identifies regulatory barriers, yet both publications suggest several initiatives involving regulation. Even when the Danish government decides to adopt the suggested regulatory initiatives, there is a potential barrier identified through the interviews that could undermine the effectiveness of the initiatives. This barrier, referred to as 'lack of implementation' by some stakeholders (Table 8), can significantly lower the impact of the adopted initiatives. The effectiveness of regulatory initiatives depends on implementing appropriate policy instruments, such as taxes or mandatory standards but if these tools are not properly put into place, the regulatory initiatives may not achieve their intended outcomes (Milios, 2020). For example, the Roadmap for circular construction recommends changes in the Building Regulations to also include requirements supporting the reduction of resource use

(Realdania, 2023b) and the Action tank for sustainable construction likewise recommends changes in the Building Regulations to include requirements for circular economy (Handletank for bæredygtighed, 2023). The misalignment between the suggested regulatory initiatives and the barriers that stakeholders experience, might result in utilizing ineffective regulatory instruments. The Danish construction industry has in recent years experienced an ineffective utilization of regulatory instruments. The Building Regulations mandate the relevant stakeholders to calculate GHG emissions of new construction (BEK nr 1673 af 11/12/2023, 2023). Even though high-level circular economy can contribute to lower GHG emissions, reused building elements had to be valued on par with new materials in the GHG emission calculations for buildings due to the lack of documentation. When reused materials count toward GHG emissions as much as new materials, lack of time, economy, and competencies (see 8) can further discourage stakeholders from engaging with high-level circular economy. This has since been changed, and reused materials are now considered to emit 0 emissions (Social- og Boligstyrelsen, 2024). If requirements for circular economy and resource reduction are unclear or their effect poorly researched, additional revisions of the regulations will be needed to adapt the requirements appropriately. Moreover, the initiatives in the mentioned publication revolve around solving the technological or market barriers. According to Kirchherr et al. (2018) and as experienced through the interviews conducted for this thesis, the most pressing barriers are cultural, arguably the most difficult to overcome.

Other barriers from the publications, especially cultural barriers, seem general, and some are even repetitive or overlapping within the same publication. For example, the barrier 'the main part of the industry continues business as usual and has not yet adopted circular solutions' is very reminiscent of the barrier 'the processes and economy of the construction industry continue to be linear' (Table 7), implicating habituality of the Danish construction industry, where processes have not developed, and everyone operates under the rules of linear economy. As mentioned previously, an economic system is a complex network of rules that have gradually evolved over the years (see 4.2). When circular economy is viewed as an economic system, we see the two mentioned cultural barriers more as a status quo of the Danish construction industry, a consequence of a still-evolving economic system trying to navigate the established set of linear rules, rather than actual barriers. An example of a rule/barrier causing the status quo is the high expenses of circular economy. Currently, the pricing of circular products follows the same rules as the pricing of linear products (Appendix 4), meaning that circular economic system not only tries to navigate the established linear rules but follows them. However, considering the "new" is valued in linear economy and the "used" is valued in circular economy, where products and materials are produced with different methods and at different speeds, the usage of the same pricing models inevitably leads to unbalanced pricing "power" of "new". As explained by one interviewee and also supported by the Roadmap for circular construction, circular economy calls for a new value proposition, where e.g. pricing of products would include the environmental and social damage caused by production processes (Realdania, 2023; Appendix 4).

Some other barriers, primarily those identified by the Action tank for sustainable construction, are more specific and resemble some of the barriers identified through the stakeholder interviews: lack of supply and demand for circular products, lack of knowledge, and unclear responsibility and unknown risks. After decades of dominance of linear economy, we believe that many of these barriers are a consequence of the linear set of rules, that formed the interactions among the stakeholders in

the industry. In the following sections, we attempt to unfold the barriers as experienced by the interviewed stakeholders and thereby explore the complexity of the linear rules and why they are so difficult to break.

9.3 Barriers as experienced by stakeholders

The following section explores what we believe is the wider set of rules in our society. Regulatory barriers are explored initially followed by the market barriers. After, cultural and technological barriers are connected in the end.

9.3.1 Regulatory barriers

Mandatory requirements are proven efficient for lowering the negative impact of the built environment (IPCC, 2022). While legislation is also recognized as an important driver among the interviewed stakeholders as well as the publications, political ambitions and lack of implementation are expressed as barriers by the interviewed stakeholders (Tabel 8). One interviewee explains that politicians are hesitant to implement climate requirements in the construction industry unless they are confident that the industry can meet these demands (Appendix 4). Similarly, DI expresses that political ambitions, i.e. mandatory requirements, must be realistic and not negatively affect the companies' productivity and earning potential (Appendix 2). In this section we explore the legislative landscape of Denmark and how circular economy fits into it.

Ambition levels

To lower the negative impact of the construction industry, GHG emission limits have been set in the Danish Building Regulations (Social- og Boligstyrelsen, 2021). However, with the current construction rate, these limits are deemed unsatisfactory for reaching the targets of the Paris Agreement and meeting the planetary boundaries (Reduction Roadmap, n.d.). Furthermore, most of the new construction in Denmark already emits less than mandatory (Social-, Bolig- og Ældreministeriets, 2024a) and therefore the Reduction Roadmap has been issued, requesting lower mandatory GHG-emission limits for all construction. The Reduction Roadmap has been met with the support of many private and public stakeholders in the construction industry (Reduction Roadmap, n.d.), including several of the interviewed stakeholders. One interviewee explains that the support given to the Reduction Roadmap's proposed emission limits is a way of showing the policymakers in Denmark that the industry is ready for stricter legislation (Appendix 4). Nevertheless, the Reduction Roadmap has not yet gotten the support of DI. As explained during the interview, DI agrees with the direction of the Reduction Roadmap and the necessity of higher ambitions, but at the same time believes that the proposed limits are unrealistic and based on wrong calculations (Appendix 2). According to the interviewee, the consequence of the limits would put a stop to the construction of single-family houses (Appendix 2), an argument disputed by another interviewee, who considers DI a part of linear construction, lobbying for its most powerful members (Appendix 4). The activities of those members would be highly impacted by the Reduction Roadmap limits (Appendix 4). Given DI's position as a representative of major companies in the Danish construction industry and considering the challenge of ambitious vs. realistic political ambitions, DI's stance can either directly or indirectly influence the political processes. Recently, The Ministry of Social and Housing has attempted to meet the ambitions of the industry, describing their proposal as a significant tightening of the requirements in the Building Regulations (Social-, Bolig- og Ældreministeriets, 2024). The supporters of the Reduction Roadmap seem

to welcome the development and some of the proposed initiatives (Valdimarsson & Kristensen, 2024). One of the most significant changes is the proposal for a possibility of denying permissions for demolition, if renovation of a building would be evaluated more reasonable (Social-, Bolig- og Ældreministeriets, 2024). The supporters, however, criticize the still unambitious GHG emission limits, where the industry will be able to continue with "business as usual" (Social-, Bolig- og Ældreministeriets, 2024). The Danish construction industry believes that the limits suggested by the Reduction Roadmap would encourage circular solutions (Valdimarsson and Kristensen, 2024), but besides the proposal regarding demolition denial, the ministry's proposal doesn't seem to consider circular economy as a part of emission reductions. According to calculations by the Reduction Roadmap, the average GHG emissions from construction projects will in 2025 naturally fall under the proposed mandatory values due to the green transition of the energy sector (Valdimarsson & Kristensen, 2024).

Regulatory ideologies

The seeming reliance on the green transition of the energy sector leads to a discussion on the (un)balanced focus between energy and resources, a concern raised by one of the interviewed stakeholders. Even though an estimated 55 % of emissions can be addressed by transitioning to renewable energy sources, and the remaining 45 % must be addressed through circular principles (European Commission, 2019), the importance of resource use in the Danish legislative landscape remains overlooked. There has traditionally been a strong focus on lower energy consumption, in recent years switching the focus to GHG emissions (Appendix 5). Denmark has a target of achieving 70 % GHG emission reduction by 2030 compared to the levels in 1990, and most regulations and other policies (such as strategies and action plans) seem to revolve around this target. One of the most important legislations is the Danish Climate Law with the associated Climate Plans and Climate Program. The program evaluates the progress of Climate Plans each year to ensure Denmark is on track with reaching the targets (Klima-, Energi- og Forsyningsministeriet, 2019). Climate Plan for Green Waste Sector and Circular Economy should contribute to the reduction of the negative impact of the waste sector through low- and high-level circular principles. The plan recognizes the importance of reuse also in the construction industry and identifies the potential of selective demolition (Regeringen, 2020), which is coming to life in 2024 (see 8). However, most of the follow-up initiatives suggested in the Climate Program 2023 primarily concern waste sorting and recycling, as well as renewable energy sources and carbon capture technologies to lower emissions of waste recovery activities, i.e. recycling and incineration. Only one initiative touches upon high-level circular economy, where repairability and long lifetime of products are mentioned only as possibilities alongside business models that would reduce the incineration of waste (Klima-, Energi- og Forsyningsministeriet, 2023). High-level circular economy in the Danish construction industry might be hindered further by the government's focus on strong recycling infrastructure. While the climate plan encourages against additional incineration facilities, the plan promotes stronger recycling infrastructure without mentioning building a similarly strong infrastructure for reuse (Regeringen, 2020).

The government's climate targets anchor to Denmark's perceived responsibility of being the leading country regarding climate initiatives to inspire the rest of the world while creating sustainable competitive power and maintaining strong societal welfare. The Climate Action Plan indicates the long-standing tradition for welfare, competitive power, and healthy economy should in the future be achieved by economically effective green transition (Klima-, Energi- og Forsyningsministeriet, 2020).

However, the same plan highlights domestic emission reduction (Klima-, Energi- og Forsyningsministeriet, 2020) and is criticized for disregarding the global impact of Danish activities (Klimarådet, 2023). This is not to say that the protection of the local environment and the well-being of the Danish society are not important, but rather to draw attention to the effect of political values and consequent targets that reaches outside the scope of the country's borders.

Diffused coordination

Another regulatory barrier, noted by one of the interviewed stakeholders, is the diffused regulation of construction aspects, where several ministries are responsible for regulating different aspects of the construction industry. The interviewee further expresses concern about the lack of coordination between the mentioned ministries, which can lead to a disorganized implementation of the new regulations (Appendix 5). As mentioned previously, the Ministry of Social Affairs, Housing, and Senior Citizens is central, as it is responsible for the Building Act and Building Regulations (see 7). However, this ministry primarily focuses on social sustainability rather than environmental aspects (Appendix 5). Environmental issues are addressed by other ministries, such as the Ministry of Environment, which is responsible for ensuring clean and safe local environment through and has developed an action plan for circular economy (Miljøministeriet, 2021). The Ministry of Industry, Business and Financial Affairs aims to improve conditions for economic growth and green transition of Danish companies (Erhvervsministeriet, n.d.b). This ministry also sets goals and guidelines for the Danish Standards, an organization developing standards. Additionally, Danish Standards is responsible for the Nordic Swan Label, a certification also used to promote sustainable construction (Dansk Standard, 2018).

According to OECD's recommendations, impact assessment of regulations should be integrated early in the policy-making process to define clear goals of the policy, evaluate whether the regulation is necessary, and identify the most effective and efficient ways to achieve the goals (OECD, 2012). While it is impossible to assess how the diffused regulation of the construction aspects contributes to the shaping of the relevant policies, the concern expressed by the interviewee might be valid, as Denmark's performance of both stakeholder engagement in regulation development, regulatory impact assessment, and post-evaluation of regulations are assessed low by the OECD (OECD, 2021) (Source OECD 2021). Considering that different ministries have different objectives (from ensuring social well-being to improving conditions for economic growth), regulatory policy-making with clear goals and early evaluation can be challenging, hindering an efficient implementation of a regulation (OECD, 2012), a barrier discussed above. Furthermore, the definition of clear goals and ways to achieve them can be influenced by the most powerful stakeholders in an industry, especially when the values of these stakeholders align with the values of politics. For example, the abovementioned regulations and plans are designed to achieve the national GHG reduction target by relying on energy-related technologies. Like the potential influence of the most powerful stakeholders on shaping GHG emission limits (illustrated above), these stakeholders might have influenced the stark focus on energy efficiency and carbon capture technologies. They are considered a part of linear construction (Appendix 4) and implementation of high-level circular economy in the construction industry might negatively impact their business and revenue. To give an example, the Danish Action Plan for Circular Economy lists several objectives and targets of the action plan, but most of them are rather unspecific. The action plan aims to reduce waste and increase recycling and reuse but fails to mention how much (Miljøministeriet, 2021). Even though the Action Plan is meant to promote circular economy and less

consumption in Denmark, most of the initiatives related to the construction industry seem to contribute to the Danish GHG-reduction goal. Some initiatives, e.g. mandatory selective demolition, could promote high-level circular economy, however, without a clear target for the reuse of construction products and with a well-established recycling infrastructure, the Action Plan might fail to support high-level circular economy. In this case, policy goal-setting regarding circular economy seems to be guided by national objectives and ideologies and is potentially influenced by the most powerful (linear) stakeholders.

9.3.2 Market barriers

While regulation can be an important factor in limiting the negative impact of the construction industry, which is also recognized by the interviewed stakeholders, the same regulation and associated policies can influence the market. The core of the political economy is the dynamics between politics and the market (see 5.1), and one interviewee reflects on the dynamics between political requirements and what the market itself can develop and implement. The interviewee brings to light the latest development in the prices of raw materials: the market might be able to self-regulate, where a drastic increase in raw material prices can change market dynamics, making reused materials and products economically more viable (Appendix 2). A drastic price increase, however, might not be enough for changes in the market, as several challenges have been detected through interviews with the stakeholders.

Circular economy is not standardized

Similar to regulation setting mandatory requirements that all relevant stakeholders must follow, several of the interviewed stakeholders expressed the possibility of setting requirements when collaborating across the value chain of a construction project (Appendix 1, 6, 8 & 10). One possible way to influence the stakeholders is certification systems, such as DGNB and the Nordic Swan Label, which have gained popularity in the last decade. These systems equip the stakeholders with the knowledge and competencies needed to meet the certification requirements. One interviewee explains they have incorporated these systems into their business and developed procedures for internal and external communication and collaboration, enabling efficiency when the certifications are requested by developers or investors (Appendix 8). This indicates that once a system is up and running with established procedures, the implementation becomes easier. While certification systems confer credibility and legitimacy upon developers who conduct sustainable buildings (source Boxenbaum and Georg, 2020), circular principles have not yet evolved into an easily applicable and incorporable system for businesses and several stakeholders have expressed the lack of standardization for circular economy as a barrier to setting circular demands to other stakeholders (Table 8). Two interviewees expressed that common language on circular economy would contribute to an easier setting of demands but would require coordination among the stakeholders regarding relevant and efficient circular principles (Appendix 7 & 8). The attractiveness of the standardized approach has most likely created a high market value for the certification systems, hence their rise in popularity, leaving high-level circular economy behind.

One interviewee also elaborates on the contractual obligations, that might influence how circular economy and stakeholders are involved in a construction process. Developers and construction enterprises are contractually obligated to each other, however, the specifics of the demands for the construction will impact the activities of other stakeholders, e.g. sub-contractors and suppliers. These

stakeholder groups are often small-size companies and knowledge about circular economy and often rely on e.g. wholesale companies to fulfill the developer's demands. They also don't have the necessary resources that would make room for circular economy to become a part of their agenda (Appendix 7 & 10).

Circular economy needs a lot of resources

Additionally, PensionDanmark argues that circular construction is not necessarily more expensive than traditional construction. According to PensionDanmark, the main challenge lies in overcoming old habits related to contract forms and guarantees, and established collaborations. According to the interviewee, these habits can be changed by challenging one's priorities and searching for new relationships. The interviewee further argues that investing in innovation to prepare for future demands is worthwhile, as an adjustable business model can be resistant to risks. Furthermore, long-term return on investment should always be considered and often proves financial benefits of circular economy (Appendix 6). Despite these arguments, many private developers prioritize making the most money in the shortest possible time (Appendix 4, 8 & 10) where taking risks by incorporating new circular methods is often seen as counterproductive to their business model (Appendix 4). When developers and investors like PensionDanmark, that are considered pioneers in sustainable construction, set stricter requirements, this impacts the capabilities of smaller companies in meeting the demands. With a lack of resources (Appendix 7 & 10), smaller stakeholders might not be able to meet the demands, affecting collaboration possibilities and commercialization of circular economy. Two interviewees highlight, that stakeholders who lack resources need support to begin engaging with circular economy. Both interviewees see knowledge sharing as a way to support these stakeholders, not only knowledge about what is important and what possibilities exist but more knowledge about how to approach circular economy (Appendix 7 & 10).

For public developers, i.e. municipalities and KAB (an administrative organization for non-profit housing), the resource constraints are even more limiting, as their construction activities are publicly financed (Social- og Boligstyrelsen, n.d.a; Appendix 1 & 10). Both, municipalities and KAB must comply with mandatory analysis of the total cost of ownership (BEK nr 1179 af 04/10/2013, 2013), to create value of long-term perspective by balancing the costs of the buildings life cycle phases without compromising the quality of a building or disregarding sustainable initiatives (Bygningsstyrelsen, 2017). Total cost of ownership should be, to the relevant extent, used in the decision-making process regarding public construction (BEK nr 1179 af 04/10/2013, 2013). This formulation implies that, even though the analysis of the total cost of ownership must be performed, the results of the analysis are not mandatory to be included in the public developer's decisions. This is often the case in the non-profit housing sector: as explained by one interviewee, housing must be available to all citizens regardless of their financial capabilities. As the housing is non-profit and should be affordable, the non-profit organizations normally don't consider the total cost of ownership but choose the cheapest options (Appendix 1). Even though the Danish government is developing tools for cost assessments to propagate the use of total cost of ownership in decision-making processes for more circular economy in the Danish construction industry (Regeringen, 2018), the challenge of non-profit housing might hinder the employment of the developed tools. Compared to non-profit housing organizations, municipalities seem to have more wiggle room regarding financial constraints, where one interviewee considers municipalities, as the biggest developers in Denmark, the frontrunners regarding circular

economy in construction (Appendix 10). While municipalities are not limited in the same way as non-profit housing organizations, their yearly budgeting must consider all aspects of welfare (Appendix 1), which can, due to higher initial costs and a general lack of resources, result in choosing cheaper construction projects rather than those who perform better long-term.

The expected efficiency of construction projects and lack of resources can also hinder the possibilities for high-level circular economy in demolition processes. As explained by some interviewees (Appendix 3, 4 & 8), selective demolition requires more time and resources, especially if building components should be reused, delaying the timeline of a construction project. Careful demolition to ensure reuse possibilities might therefore become unattractive to developers. Furthermore, with the current construction practices, the developer is responsible for the materials and products with reuse possibilities. If the developer does not use those products in its own construction project, the developer must use resources to find either another developer or construction company who could make use of those products or long-term storage where the future of the products is unknown (Værdibyg, 2020). Besides the responsibility of using or storing the materials, pricing of the products with reuse potential challenges the economic viability of circular products. As explained earlier (see 9.2), the pricing of circular products follows the same pricing models as linear products. Here, labor, storage, transportation, and treatment costs are all included in the pricing of circular products. When circular products are produced in Denmark, where process costs are high, they are unattractive compared to linear products, which are often manufactured in countries with low process costs (Appendix 4 & 5). Well-developed recycling infrastructure, where storage and transport don't present a challenge for developers, further questions the possibilities for high-level circular economy in the Danish construction industry.

Investments in circular economy

Besides regulations and the stakeholders' own interests, the market can also be shaped by public and private investments and several investment opportunities can also be found in Denmark. The funds of the Recovery and Resilience Plan for quick recovery after Covid 19 crisis should stimulate accelerated green transition. The European funds are in the Danish Recovery and Resilience Plan divided between seven areas, e.g. healthcare system, agriculture, and digitalization, but almost 90 % of the funds are funneled into the green tax reform, to incentivize the Danish industry to reduce their GHG emissions (Finansministeriet, 2021). Most initiatives in the Green Tax Reform are in line with the Climate Law and Climate Programs (see 9.3.1). Only one initiative is directly related to the construction industry, where the government decides to continue the dialog with Climate Partnerships (Regeringen, 2022), which are partnerships between influential industry stakeholders working to reuse GHG emissions, while strengthening companies' green competitiveness (Erhvervsministeriet, n.d.a). Another promising initiative in the Green Tax Reform is the establishment of the Green Fond for investments in green transition of Denmark (Regeringen, 2022), which, however, completely overlooks the construction industry and circular economy (Regeringen, 2024). On the national level, only the 2024 Finance Act secures funding of circular economy projects regarding reparations and reuse of products, this initiative is assigned DKK 10M (Regeringen, 2023). Considering the DKK 3,9B allocated to the green tax reform and DKK 2B to energy efficiency and carbon capture storage (Finansministeriet, 2021), the DKK 10M seem negligible and will most likely not co-fund circular construction projects.

Of the private organizations, Realdania, a non-profit philanthropic organization (Realdania, n.d.), and financial institutions such as PensionDanmark, seem to be the frontrunners in investing in circular construction projects and are well-known among the interviewed stakeholders (Appendix 6). While this is important for kick-starting the change and demonstrating potential, one interviewee considers these projects to be elite (Appendix 7), strengthening the image of the stakeholders with enough knowledge and economic resources, but not contributing to the commercialization of circular construction.

9.3.3 Cultural and technological barriers

Some of the cultural barriers were touched upon in previous sections, including the analysis of the stakeholders' approaches to circular economy. This suggests that cultural barriers indeed are the most pressing ones. Due to the disagreement between academic studies on what barrier category is the most pressing and important to overcome, this section explores cultural and technological barriers to identify potential connections.

Competences, collaborations, and coordination

A construction project is described as a complex process involving varies stakeholders, with the greatest deal of complexity lying in the organizational aspects (Wood & Gidado, 2008). While previous academic literature emphasized technical aspects as key barriers for circular economy implementation (Kirchherr et al., 2018), the organizational complexity suggests a stronger focus on the planning process and coordination between stakeholders. This shift in focus addresses the types of competencies that companies in the construction industry need to develop. Roadmap for circular construction highlights that the industry demands not only technological development but also knowledge and a deeper understanding of organizational solutions (Realdania, 2023b). These organizational solutions can refer to organizational structures with a single company or in relation to a construction project, where stakeholders across the value chain need to communicate and collaborate. One interviewee pointed out that developers often choose the same collaboration partners, enter the same types of contracts, and in general find it difficult to break their usual habits when planning and organizing a construction project (Appendix 6). This reflects the conservative and traditional nature of the construction industry, which leaves limited room for innovation and new ideas. Such conservatism is challenging for the implementation of circular economy, as circular construction requires different competencies than traditional construction. If this need for change is not widely acknowledged in the construction industry, it can hinder new types of collaboration along the value chain and delay the development of organizational competencies.

Based on the prevalent technological barrier, inconsistent data (Table 8), an example of a competency, that many stakeholders are presumably challenged by, is data management and utilization. Effective data management is crucial for decision-making, and it involves collection, organization, and maintenance of data (Stedman, n.d.). Implementation of circular economy as well as the authorities' focus, present several challenges regarding data. For reporting on the EU taxonomy related activities, businesses must report financial figures in relation to circular economy, i.e. how much of the turnover was due to circular economy activities in the company (Jadhav & Kaur, 2023). CSRD, another sustainability reporting, requires reporting on e.g. share of recyclable and recycled materials in a company's operations (European Commission, n.d.a). Additionally, mandatory calculation of a life-cycle of new

construction (BEK nr 1673 af 11/12/2023, 2023, p. 16), requires a third data set, unrelated to the previous two. To collect the mandatory data, communication in the value chain is necessary. To optimize the collection and utilization of data, coordination among the stakeholders could be beneficial: finding an agreement on how data is composed and finding ways to help each other with e.g. calculations or providing missing information, can reduce both, the barrier of inconsistent data and lack of competencies.

Lack of initiative and complex responsibility

Lack of initiative and different ambition levels is the most prevailing cultural barrier (Table 8). This is in line with the lack of a circular strategic approach among the stakeholders (see 8), which suggests that companies have not mainstreamed the concept yet. Besides politicians, developers and investors are highlighted in the Roadmap for circular construction as stakeholders who should have a driving role and take the initiative to incorporate circular principles. PensionDanmark is one of the investors prioritizing high levels of circular economy and sees it as their responsibility and something that is expected of them (see 8). Nevertheless, many developers and investors have not adopted circular principles in their businesses. An analysis from 2019 shows that around 80 % of developers don't have a written strategy for how to promote reuse and recycling in construction projects. Consequently, developers without a written strategy usually don't set requirements for contractors and suppliers (Teknologisk Institut et al., 2019). This supports the importance of a strategic approach for circular economy, as argued in 7.2. One interviewee (Appendix 8) also argues that the initiative to implement circular economy in a construction project is only needed from a few key players, namely the developer, consultants, and contractors, who agree on the overall contract for a construction project. This indicates that a clear strategy and vision adopted by the stakeholders involved in the beginning stages of a construction project (see 7) are important for circular direction of the project.

Until now, we have isolated our focus on initiative and responsibility regarding which stakeholder group is and should be responsible for initiating circular practices, but responsibility was also mentioned in relation to unknown risks and potential safety hazards. This cultural barrier is tightly interconnected with the technological barrier of unknown risks of new and circular materials and products (Table 7). Several stakeholders have mentioned that circular materials and products lack documentation for their safety, which is why the stakeholders with the most influence on circular economy, shy away from using those products, as all responsibility regarding risks would be on them (Appendix 8 & 10), resulting in lack of initiative (Table7).

9.4 Underlying reasons

The analysis of the barriers simultaneously invites discussion on the possible effects of various elements of market and politics (e.g. strategies, actions plans, and public investments). Some interesting dynamics have been observed, not only challenges, but also opportunities. To highlight one, we would like to direct the attention to the strong unity regarding strict GHG emission levels. This suggests, that strong analytical methods and science-based arguments can bring a whole industry together. This report revolves around barriers and underlying reasons for them as we consider this the first step to breaking the old habits. Therefore, we focus on these and suggest further research to identify other opportunities. The three tables below (Table 9, Table 10 and Table 11) provide an overview of underlying reasons from the second and third analyses. The underlying reasons are divided

between the three lenses of political economy: 1) Change processes, 2) Power relations, and 3) Ideologies, values and perceptions.

Tabel 9: Change processes hindering circular economy in the Danish construction industry.

Change processes	
Regulatory	- Governmental investments in recycling infrastructure and lack of governmental investments in infrastructure for reuse - Diffused regulation of construction aspects - Lack of regulatory impact assessment during the preparation of policy - Regulatory misalignment in identified potentials and implemented initiatives - Vague regulatory definition of high-level circular initiatives
Industry	- Established and wide-spread recycling infrastructure and lack of infrastructure for reuse - Broad spectrum of needed competences including organizational - Barriers in industry's publications are vaguely defined - Vague goals for reuse discourages change of business model - Ambitious demands indirectly prioritize collaboration with resourceful stakeholders - Commercial attractiveness of certification systems - Project contracts misaligned with responsibilities and resources of affected stakeholders - Total cost of ownership is not a decisive factor and there is no definition of the "relevant extent"
Both	- Construction projects are attractive when effective and productive, discouraging stakeholders from taking risks - Circular products follow the same pricing models as linear products - Disorganized approach and lack of targets for high-level circular economy

Tabel 10: Power relations hindering circular economy in the Danish construction industry.

Power relations	
Industry	- A lot depends on developers' values, capacity, and ambitions - Influential stakeholders doubt the reliability of calculations - Project contracts misaligned with the responsibilities and resources of affected stakeholders - Total cost of ownership is not a decisive factor and there is no definition of the "relevant extent"
Both	- Influential stakeholders dictate the strategic direction - Powerful stakeholders collaborate and strengthen the ideology of recycling - Influential stakeholders might not support the industry's ambition levels

Tabel 11: Ideologies, values and perceptions hindering circular economy in the Danish construction industry.

Ideologies, values and perceptions	
Regulatory	- Protection of local environment - Policy goal setting and investments for circular economy guided by national ideologies
Industry	- High-level circular economy threatens linear stakeholders - Circular strategic approach deemed unnecessary
Both	- Guidelines for resource mapping prioritize time and economy - Waste is valuable - Reliance on renewable energy and energy efficiency - Resource consumption not recognized as an important focus area

10 Discussion and conclusion

This thesis builds on the frustration that authors have been experiencing throughout the studies. Circular economy, even though not a new concept, is still often referred to as a novelty. Barriers to circular economy as well as solutions to overcome them have been identified many times before, and awareness among academics and companies about the importance and commercial relevance of circular economy is increasing, and yet, the construction industry is hesitant to buy into it. Therefore, we are inspired by some of the key questions and concepts of political economy, such as who or what drives the change, what is seen as valuable, and who or what shapes the market. Our goal is not solely to contribute to the academic research, but rather to encourage the stakeholders in the industry to a broader, more nuanced dialog. The research question is therefore directed toward the stakeholders in the Danish construction industry and their understanding of the barriers. This thesis aims to answer the research question: How can political economy analysis contribute to the stakeholders' understanding of barriers to circular economy in the Danish construction industry and encourage an intricate dialog to accelerate the implementation of circular principles? Several steps are taken before answering the question.

In the first step, the stakeholders in the Danish construction industry are mapped. External stakeholders are mapped based on categories combined from PEA framework and academic literature, and internal stakeholders are mapped based on the stages of a construction project. Stakeholder groups are used to understand their general role and extract their relevance for circular economy in the industry. Authorities hold significant power through legislation, as they can remove legislative barriers and promote high-level circular economy through supportive laws. Business associations like DI Construction are also crucial in shaping the circular economy, as they represent numerous and influential companies, and their standpoints can therefore influence how circular economy is tackled across the industry. Associations also engage in political dialog and create good market conditions for their members. Early stages of the construction value chain are critical, and therefore, developers hold substantial power in integrating circular economy from the beginning to influence the entire value chain effectively.

The second step focused on the stakeholders' approaches to circular economy to understand initial influences and potential trajectory of circular economy if the business continues as usual. We conclude that many stakeholders focus on waste sorting and recycling of resources to comply with the legislation. Most of the stakeholders have not yet integrated high-level circular principles. Furthermore, many stakeholders lack a strong strategic approach to circular economy, resulting in a disoriented approach with missing coordination and circular goals. There is a growing interest in reuse and renovation, particularly among large developers and there seems to be an alignment among various stakeholders on the importance of renovation and transformation. However, established CDW recycling infrastructure and economic and time constraints pose significant challenges to achieving high-level circular economy. Findings of this analysis are brought into the analysis of barriers.

The third step begins with an overview of the barriers to circular economy in the Danish construction industry and a discussion on how the Danish barriers are similar to or differ from the theorized academic barrier. The latter are a good starting point but are not context-specific. Then, the barriers in the two Danish publications are discussed. We find these barriers too vague, potentially leading into misaligned solutions or utilization of inappropriate regulatory instruments for the implementation of

solutions. Due to political economy's focus, dynamics between politics and market, regulatory and market barriers are then analyzed and discussed, drawing on the interviews and different (mostly) Danish publications. Regulatory barriers are divided into three sub-topics, ambition levels, regulatory ideologies, and diffused coordination, which correspond to the regulatory barriers identified through the interviews. Favoritism of the reduction of GHG emissions, reliance on renewable energy, misaligned ambitions between policy-makers and the industry, lack of policy evaluation during preparation and lack of clear regulatory targets for circular economy can be singled out. Market barriers are also divided into three subtopics, circular economy is not standardized, circular economy needs a lot of resources, and investments in circular economy. Here, the following challenges can be highlighted: lack of standardization makes circular economy commercially unattractive, lack of resources might negatively demand smaller stakeholders when met with demands from developers and investors, and investments seem to be driven by regulatory ideologies and not industry's capabilities. Cultural barriers are touched upon in the second analysis as well as in the analysis of regulatory and market barriers. Technological barriers are by some scholars considered the easiest to overcome, and can be a direct consequence of other barriers. Therefore, we combine these two barrier categories and divide the section into two parts. First, competencies, collaborations and coordination are analyzed and discussed, followed by lack of initiative and complex responsibility. We find a strong connection between technological and cultural barriers and dispute the academic research emphasizing the importance of one or the other category.

The analysis and discussion of the barriers lead to discovering several underlying reasons within the chosen PEA lenses: change processes, power relations, and ideologies, values and perceptions. Some underlying reasons are regulatory, some concern the industry, and some can be linked to both. We considered the underlying reasons to be a more nuanced version of the barriers, presenting the set of rules that circular economy is navigating. Findings show a regulatory reliance on renewable energy and energy efficiency as primary solutions to environmental impacts, influencing stakeholders' circular activities and choices. Consequently, this has led to a fragmented approach and investments continuously tend to favor recycling and energy renovations over high-level circular principles. The perception of waste as valuable is a strong ideology in the construction industry, only further supported by established recycling practices and missing competencies needed for high-level circular practices.

Adopting a political economy perspective has revealed what potentially hinders the change and what can drive the change. We have identified influential stakeholders in the Danish construction industry, who can drive the change if adopting circular principles and a strategic approach to promote new collaboration and communication. Furthermore, we found an important driver in regulation, i.e. GHG limits in new construction, which can either block or kick-start the change depending on the ambition level. Besides the influential stakeholders and legislation, we also discovered strong values and ideologies in the industry, one of them being that waste is valuable for both construction stakeholders and authorities, which is blocking the willingness to seek new competencies and collaborations for high-level circular economy.

With the insights from this thesis, stakeholders in the Danish construction industry can become more aware of what structures and dynamics can be causing the more obvious barriers they experience in their daily operations. To kickstart the change, we suggest a dialog about the common denominator

of the three lenses: vague definitions and targets. Although Denmark has a very clear target for the reduction of GHG emissions, where construction industry must contribute with complying with the new GHG limits, the same cannot be said for circular economy. Here, no targets on the national level have been identified and only a few stakeholders in the value chain have targets related to circular economy, however, low-level circular economy. Defining clear targets can help stakeholders develop strategies and detailed action plans with allocation of resources and relevant activities. The underlying reasons can also change the perspective on a barrier. An example of this is the barrier lack of competencies and resources, which is further rooted by the underlying reason 'broad spectrum of needed competencies including organizational', where stakeholders often lack resources to develop their competencies. The two might be reminiscent of each other, but the formulation itself might encourage a more nuanced dialog. 'Lack of competencies' implies that there are not enough competencies and due to lack of time and economic resources nothing can be done. 'Broad spectrum of competencies including organizational' implies that there are enough competencies, makes one aware of organizational competencies, which are often overlooked, and can lead one into searching for stakeholders with those competencies.

This research has done a sector-level analysis of the Danish construction industry by utilizing concepts from the political economy analysis framework. Similar approach can be applied on company-level, which can provide insight into how strategies and activities affect other stakeholders, and consequently promote more thoughtful and effective stakeholder engagement. We encourage further exploration of barriers to circular economy from a political economy standpoint as it is essential to get a deeper understanding of the interconnections between the barriers, which can reveal new and more appropriate or cohesive solutions to some of the underlying reasons.

Appendix 1: Interview notes – KAB

Date: 21/2-2024

1. Role and responsibilities of the interviewee:

- Oversees the construction and management of public housing.
- Responsible for ensuring that existing housing is adapted to new housing forms and needs over time.

2. Public tenders and economic viability:

- Public tenders must be economically viable, meaning they need to balance initial construction costs with long-term operational expenses.
- KAB must adhere to EU tendering rules which require considerations of both cost and sustainability
- It was discussed that sometimes choosing a slightly more expensive option initially can result in lower long-term costs, emphasizing the importance of total economic analysis.

3. Strategic processes and risk distribution:

- Strategic processes at KAB are influenced by the collective decisions of the 35 housing organizations that own it.
- Risk distribution involves these local housing organizations deciding on priorities for their projects, such as whether to focus on green energy solutions like solar panels or other community needs.

4. KAB's vision and local decision-making:

- KAB aims to create inclusive housing for a diverse range of social groups, avoiding segregation by integrating various types of housing within communities.
- Local housing organizations have significant autonomy in decision-making for their specific projects, deciding on priorities that reflect the needs and desires of their residents.
- There is a shared policy framework that guides all housing organizations under KAB's administration, ensuring a cohesive approach to housing policy.

5. Circularity and innovation in construction:

- KAB is committed to sustainability, working on reducing energy consumption and incorporating circular principles, although the term "circular economy" is not frequently used.
- The focus is on both environmental impact and social dimensions, aiming for low energy consumption and high awareness among residents.
- Certifications like DGNB and the Nordic Swan Ecolabel are discussed, with some criticism regarding their cost and practical value.

6. Coordination and collaboration:

- The Coordination Committee for Sustainable Construction was established to ensure the national strategy for sustainable construction is anchored and developed.
- A sustainability network was created to bring together various stakeholders, including contractors, engineers, and housing associations, to develop concrete tools and strategies for reducing CO2 emissions and achieving sustainability goals.
- The network works in specific subgroups focusing on areas like building renovation and standardization, aiming to address practical challenges and implement sustainable practices effectively.

Appendix 2: Interview Notes – DI

Date: 04-03-2024

1. Role and structure of DI

- DI is a comprehensive association within the construction sector, covering a wide range of activities from construction to consultancy and material production.
- Interviewee's role is to advocate for infrastructure contractors involved in projects like roads, railways, bridges, harbors, and more.
- DI represents both large and small contractor companies.

2. Focus on infrastructure projects

- The majority of DI's members work on public sector projects, making them subject to political and regulatory influences.
- Infrastructure projects necessitate close adherence to public funding and approval processes.
- Emphasizes the structural differences between building infrastructure and constructing buildings, pointing out the demands and regulatory environment of infrastructure projects.

3. Circular economy

- DI works to develop circular economy practices within the construction sector, driven by political and consumer pressures to reduce CO2 emissions and resource consumption.
- Initiates dialogues with member companies to identify barriers and opportunities for new methods.

4. Challenges and risk management

- Discusses the apprehension around using new materials due to potential unknowns and risks, exemplified by the MGO board issue which was unsuitable for the Danish climate.
- Advocates for mechanisms to manage and mitigate these risks, such as an exchange fund similar to a storm flood fund to cover potential failures.
- Highlights the complexity of meeting new environmental standards and the need for industry-specific solutions.

5. Public statements and industry perception

- Reflects on past statements about the construction sector's dependency on public projects and the importance of aligning construction activities with actual demand.
- Discusses the sector's sensitivity to economic cycles and the significant role of public investments during downturns.
- Emphasizes the need for informed and balanced regulations that support circular growth without imposing unrealistic demands.

6. Industry collaboration and responsibility

- Encourages ongoing dialogue within the industry to collectively address challenges.
- Focuses on shared responsibility among stakeholders to adopt and implement new materials and methods safely and effectively.
- DI takes a proactive role in leading circular efforts, working closely with members to develop feasible and impactful strategies.

Appendix 3: Interview notes – Norrecco

Date: 08-03-2024

1. Norrecco's role and operations

   - Norrecco handles various types of waste, including hazardous materials like asbestos and PCB. They ensure proper disposal and recycling processes.
   - They are responsible for documenting the receipt and handling of hazardous materials, such as asbestos, ensuring regulatory compliance.

2. Recycling and reuse initiatives

   - Norrecco is involved in projects aimed at enhancing circular economy within the construction industry. This includes the 'circular construction site' project, which focuses on efficient material handling

3. Collaborations and certifications

   - Norrecco works with companies like Unicon and Knauf to supply certified recycled materials, ensuring they meet technical standards for reuse. They also collaborate with Pelcon for material testing and certification.
   - They certify materials like concrete aggregates and recycled bricks, ensuring they meet EU standards for quality and safety.

4. Challenges and industry impact

   - Does not acknowledge the potential for Norrecco's business model to be impacted if all materials were perfectly recyclable on-site. However, he believes that processing will still be necessary for many materials, ensuring continued demand for their services.
   - Norrecco is exploring new technologies and processes to improve recycling efficiency, such as making cement out of used cement.

5. Regulatory and environmental considerations

   - Norrecco has specialized processes for handling and disposing of hazardous waste, including international agreements for deposing materials in specialized facilities in Germany.

6. Future innovations

   - Norrecco suggests potential international collaborations and educational exchanges to improve recycling practices globally, indicating an openness to learning and innovation.

Appendix 4: Interview notes – Circue

Date: 12-03-2024

1. Role and responsibilities

- Interviewee is CEO and co-founder of Circue APS
- Initially led a research project, coordinating work packages and digitizing knowledge into a platform
- Acts as an intermediary between market needs and development
- Gathers feedback from stakeholders to refine the platform

2. Circue platform

- Developed to facilitate circular economy in the construction industry
- Ensures transparency and accountability through tracking and documentation
- Tests and certifications are signed off by relevant experts

3. Circular economy in construction

- Promotes reuse and recycling of building materials
- Supports circular construction practices
- Encourage to decide whether to preserve, transform, renovate, or demolish buildings based on material reuse potential
- Integrates circular economy principles from early stages of construction planning

4. Challenges and risks

- Mentions risks associated with reused materials
- Collaborates on projects like Material passport to standardize documentation and testing
- initiatives like a risk fund to mitigate systemic risks of using recycled materials

5. Collaboration and stakeholders

- Collaborates with engineers, environmental surveyors, and resource mappers for comprehensive testing and certification
- collaboration with projects and organizations as Structural Reuse and Materialepasset

6. Future goals

- Improve data quality and standardize testing and documentation
- Reduce risks through comprehensive insurance and certification processes
- Mainstream the use of recycled materials in construction, making them as reliable and widely accepted as new ones

Appendix 5: Interview notes – Concito

Date: 14/03-2024

1. Role and responsibilities of the interviewee

- Interviewee is a senior advisor at concito.
- Focuses on promoting green initiatives in the construction industry.
- Leverages his extensive network and experience to support circular efforts.

2. Circular economy and responsibility

- Mention barriers to adopting circular economy practices in construction.
- Complex regulations (ab 92 and ab 18) create unwillingness to use new materials.
- Stakeholders avoid taking initiative due to perceived risks
- Emphasis on the need for clear guidelines and shared responsibility to promote circular practices.

3. Insurance and risk management

- Need for risk management solutions, such as a risk fund similar to the building damage fund.
- Proposed risk fund to cover potential long-term issues with new/recycled materials.
- Greendozer's approach integrates insurance for recycled materials to mitigate risks.
- Encourages the use of recycled products in construction by offering financial protection.

4. Climate goals and regulations

- Introduction of climate requirements for new buildings, including co2 limits, following recommendations from the climate partnership for construction.
- Part of a broader national strategy to reduce energy consumption and co2 emissions through more stringent regulations every two years until 2030.
- Promotion of biogenic building materials and the reuse and recycling of existing structures.
- Aims to achieve sustainability in construction by setting progressive environmental targets.

5. Innovation and market trends

- Rapid development and growing interest in circular building materials and practices.
- Emergence of new market actors like genbyg and digital solutions such as ai for resource mapping of buildings before demolition.
- Digital solutions enhance transparency and efficiency in reusing building materials.
- Companies are exploring new business models and technologies to support circular economy practices despite higher costs compared to new materials.

6. Challenges in implementation

- Logistical issues, higher costs, and need for clear responsibility and risk management.
- Companies like genbyg and greendozer face challenges in making recycled materials cost-competitive with new ones.
- Supply chain complexities hinder the widespread adoption of recycled materials.
- Unwillingness of contractors, architects, and engineers to take responsibility for new materials complicates adoption.
- Need for collaborative efforts and innovative solutions to overcome these barriers.

Appendix 6: Interview notes – Pension Danmark

Date: 19-03-2024

1. Role and responsibilities

- Interviewee is the chief of sustainability at pensiondanmark
- Developed the program for sustainable initiatives
- Establishing contemporary and appropriate requirements and conditions for all construction projects.
- Ensuring projects are less environmentally impactful, based on the dgnb system (german sustainable building council).

2. External collaborations and knowledge sharing

- Active involvement in various external organizations, such as:
  - Council for sustainable building
  - Developers' associations
  - Building societies
- Maintain updated knowledge and foster collaborations necessary for circular practices.

3. Approach to development

- Unlike many other pension funds, Pension danmark undertakes development and developer roles internally.
- Ensures control over financial aspects and construction quality, reducing potential risks.

4. Circular economy practices

- Pension danmark integrates circular economy principles into their projects, emphasizing reuse and recycling of materials. For example with fælledby project: repurposing materials from an old building for new construction.
- Works with companies like fischer leiten to modernize and resell used lamps, promoting resource efficiency.

5. Strategic goals and implementation

- The sustainability program encompasses circular solutions and aligns with the DGNB system to reduce co2 footprints and resource consumption.
- Incorporates flexibility in construction to facilitate future disassembly and reuse of materials.

6. Challenges and opportunities

- Guarantee and insurance can hinder the use of recycled materials.
- Traditional thinking and standard practices in construction can act as obstacles.
- Pushes the construction industry and suppliers towards adopting more circular practices.
- Implements circular solutions in their offices and projects, serving as a model for the industry.

Appendix 7: Interview notes – AO

Date: 02-04-2024

1. Role and responsibilities:

- Interviewee leads efforts to minimize AO's environmental footprint through initiatives such as CO2 reduction, waste sorting, and other measures to minimize the company's impact.
- He focuses on developing environmentally friendly solutions for customers, encouraging the adoption of products with lower environmental impact.

2. Climate initiatives:

- Although AO's approach to circular economy is not highly structured, they engage in practices like tool and machine rentals and repair services for their customers. They also collaborate on one project to reuse returned goods with minor defects.
- AO proactively addresses upcoming pressures from the EU's CSAD and EU-taxonomy by incorporating goals as circular economy principles, even before these regulations fully mandate them.

3. Circular economy approach:

- AO participates in initiatives like equipment rentals and repairs, and a project with a customer to reuse returned items with cosmetic defects.
- Interviewee aims to integrate more structured circular economy practices into AO's operations, aligning with regulatory expectations and internal goals.

4. Barriers and opportunities:

- A significant challenge is the absence of standardized data and processes in the construction industry, which complicates the implementation of circular measures.
- There is a lack of recognition of wholesalers' roles in the construction sector, both in academic literature and industry practice. This underrepresentation hinders their involvement in broader circular initiatives.

5. Specific goals:

- AO aims to be a leader in the green transition, focusing on climate change mitigation and circular economy. These areas are seen as crucial for the company's future success and compliance with emerging regulations.
- A key objective is to improve data transparency and accessibility, enabling better circular practices across the construction industry value chain.

6. Recommendations and future directions:

- AO plans to actively participate in industry groups and partnerships to drive sustainability forward. This includes reaching out to potential partners and stakeholders to foster collaborative efforts.
- AO emphasizes the need for structural changes within the industry to support sustainability goals. This involves creating clear guidelines and support systems for small contractors and wholesalers to meet new environmental standards.

Appendix 8: Interview notes – Arpe & Kjeldsholm

Date: 04-04-2024

1. Background and role

- Interviewee has been with the company for 9 years, transitioning from a client role. She now serves as the head of sustainability.
- Responsible for ensuring the company meets sustainability goals in all projects, bids, and certifications.

2.circular strategies

- Focus on renovation and reuse, particularly in the early stages of projects.
- Consideration of how buildings can be dismantled to maximize material reuse.
- Implementation of pilot projects to test and refine circular practices.

3. Collaboration with stakeholders

- Engages with various actors in the value chain during a construction project, including suppliers, waste management companies.
- Emphasizes open communication and cooperation between clients, contractors, and consultants to ensure smooth project execution, but usually it is not what happens. Often there is a lack of communication and collaboration.

4. Challenges in the construction industry

- Talks about economic and structural barriers that slow down the adoption of circular practices in the construction industry.
- Notes the complexity of the sector and the need for clear communication and understanding of terms like circular economy.
- Highlights the difficulty in securing guarantees for reused materials, which deters clients from choosing circular options.

5. Impact of EU legislation

- Discusses the upcoming EU regulations and their significant impact on the company, including the need to comply with extensive documentation requirements.
- Points out that even small to medium-sized companies will have to meet stringent EU standards, similar to larger corporations.
- Focuses on preparing for these regulations by ensuring all internal systems and procedures are aligned with new requirements.

6. Future focus and goals

- Aims to enhance the company's ability to manage large projects sustainably, ensuring compliance with certifications like DGNB, BREEAM, and LEED.
- Continues to advocate for the integration of circularity into most of the company's operations.

Appendix 9: Interview notes - Letbek

Date: 16-04-2024

1. Company overview

- Letbek is a production company creating products out of plastic for various sectors including construction, furniture, and agriculture. They manufacture items for fish farming and poultry feeding among other industries.
- Letbek's strength lies in their ability to produce diverse items and adapt to different market needs rather than focusing on high-speed production of uniform products.

2. Role and responsibilities

- Interviewee is a chemical engineer specializing in plastics, with a background in working with LEGO on plastic materials.
- Her responsibilities encompass calculating climate accounts, setting strategic goals, and managing various environmental and governance-related tasks within the company.

3. Initiatives within the company

- Approximately 71% of the materials used by Letbek last year were recycled within their facility, highlighting their commitment to circular practices.
- The company is exploring various green energy solutions such as solar panels, geothermal energy, and biomass heating to reduce CO2 emissions.

4. Circular economy

- Letbek integrates a circular economy model by recycling a significant portion of their materials and reintroducing them into production.
- Collaboration within their value chain is crucial for circular economy practices, although it presents challenges due to varying organizational priorities and resource constraints.

5. Challenges and adaptability

- Effective circular economy practices require dedicated resources and mutual understanding among all stakeholders in the value chain, which is often difficult to achieve.
- Letbek aims to set and meet KPIs, which involves demanding similar commitments from their customers to ensure a cohesive approach to circularity.

6. Future goals and initiatives

- Letbek has recently committed to the Science-Based Targets initiative, setting baselines and goals for reducing greenhouse gas emissions in line with global standards.
- The company is actively exploring different energy solutions and making decisions based on CO2 savings and cost-effectiveness. This involves continuous dialogue and planning to implement the most viable solutions.

Appendix 10: Interview notes – FLD

Date: 23-04-2024

1. Role and responsibilities

- ensuring alignment with sustainability goals.
- Working with subcontractors to implement circular practices.
- Preparing sustainability reports and meeting stakeholder demands.
- Ensuring departments adhere to circular practices.

2. Communication

- Regular updates and coordination within the company to ensure everyone is informed about sustainability/circular initiatives and their roles.
- Engaging with stakeholders, such as municipalities and subcontractors, to promote the company's circularity efforts and ensure compliance with external requirements.
- Conducting training sessions and initiatives to raise awareness about sustainability among employees and subcontractors.

3. Sustainability

- Implementing and promoting practices focused on the reuse and recycling of materials
- Aligning projects with broader goals, including the United Nations' Sustainable Development Goals (SDGs). Focusing on specific goals rather than all 17 to ensure depth and effectiveness in implementation.
- Developing strategies to ensure waste is sorted and recycled properly on construction sites.

4. Projects

- A major initiative focused on reusing materials, which has gained attention from other municipalities for its innovative approach.

5. Challenges

- Keeping pace with rapidly changing sustainability regulations and ensuring ongoing compliance, which requires constant monitoring and updating of practices.
- Ensuring subcontractors understand and adopt the company's circular practices. This includes providing resources and training, as many subcontractors may not be initially familiar with sustainability concepts like the SDGs.
- Finding projects that balance cost-effectiveness with high circular standards. This often involves making strategic decisions to avoid purely price-driven projects and seeking those that value environmental and social governance (ESG).

6. Strategies

- Creating resources and training programs to help subcontractors meet sustainability standards. This includes initiatives to educate subcontractors on sustainability and provide them with the necessary tools to implement these practices.
- Regularly updating strategies and practices based on feedback and new insights.
- Investing in internal projects and training to ensure all employees are well-versed in circular practices

Appendix 11: Interview guide

Conversation with Thomas Fabian Delman, CEO & co-founder of Circue

Participants: Thomas Fabian Delman, Nivetha Satgunalingam, Lara M. Eller, Sara M. Stedstrup
Date: 12/3-2024

Topics and questions

Role and responsibilities

1. What is your role as CEO of Circue?
    a. What are your responsibilities in that role?

Circue's contribution to the circular transition of the construction industry

1. How does Circue work with circular economy?
2. How does Circue define the concept?
    a. What has inspired that definition?
3. What barriers and opportunities does Circue encounter when implementing circular initiatives?

Collaboration

1. Who does Circue collaborate with on upscaling circular initiatives and how?
    a. What requirements does Circue set for the collaboration??
2. With the circular transformation of the construction industry, who do you see as key players?
    a. What new roles and responsibilities should they be adopting?

Circue's goals

These questions relate to the goals on Circue's website.

1. How do you work with the uncertainty of reused building materials?
    a. Technical and environmental properties
    b. Responsibility and risk distribution
2. Can you elaborate on the meaning of 'coherent value chains'?