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MASTER'S THESIS

Towards the circular economy -
A qualitative study of the barriers and drivers of
reusing materials in the construction industry

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Jeg bekrefter at arbeidet er selvstendig utarbeidet, og at referanser/kildehenvisninger til alle

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Summary

The building and construction sector uses many raw materials and produces many greenhouse gas emissions. Around 40% of the total greenhouse gas emissions produced globally comes from the construction and building industry. This mainly consists of the use during the life cycle of the building, not only the construction phase but also the production of the materials needed and the transportation of it. Additionally, the construction and building produce an immense quantity of waste. The primary research in this project is about the reuse of materials in the construction industry. This is a method for implementing a circular economy in the construction industry, in which the amount of waste and greenhouse gas emissions can decrease considerably.

The project aims to research the drivers and barriers to reusing materials in the construction industry. Reusing materials hasn't been done many times before in Norway. The research focuses on one pilot project in Bergen, Norway and compares some criteria with a project in Cape Town, South Africa.

The research question is divided into several questions; one main question aims to understand the drivers and barriers that will probably affect the project. It is not only the materials but also the actors and processes involved in the project are that part of the examination made. At the same time as it is divided into two sub-questions; where the first is about the learning process and how it can help overcome some barriers. And the second is the organisation, how the project's supply chain gets altered, at the same time as it shows ways to overcome the barriers.

The collection of data for this project was through a qualitative method, in which both interviews and observations were made. This collected data is used with the literature to discuss the research questions.

Acknowledgement

My interest in the green transformation started during a trip to Southeast Asia, and since then, I have known that I wanted to be part of the change. This project allowed me to look at an innovation that connects some knowledge I had from my studies as a civil engineer in construction with the desire to be part of the green transformation. It has been a pleasure to study this adaptability in an industry I will have the gratification of working in the following years.

I have several people I want to thank for this joy. Firstly, Nora Geirsdotter Bækkelund for being so patient and following me through the whole project. Thank you for guiding and coming with many significant inputs. I have been lucky to have a supervisor that has always been available for discussions. You have often saved me from not knowing where to start or how to continue. I also want to thank the faculty of engineering and natural sciences for the opportunity of travelling to South Africa. And a big thank you to Inger Beate Pettersen for organising the trip, not only for me but for a whole group, making the meetings and the collection of data possible.

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1. Introduction

1.1 Background for choosing the topic

In 2016 the European Union made public the common goal of becoming a low-emission society (FN, 2020). This goal was set to deal with climate change. This goal involves each country formulate their requirements that suggest measures to reduce greenhouse gas emissions. Norway is among the most ambitious countries in cutting greenhouse gas emissions. The government has set the main achievement of being climate neutral by 2050 (FN, 2020).

This is an excellent reason why many industries started to change; companies were pushed to think in new ways and innovate to reduce the climate gas emissions. The construction industry, which is the focus of this thesis, is one of these.

The construction industry stands for around 40% of the total energy use and climate gas emissions globally (Dragland, 2015). The greenhouse gas emissions generated during a construction project don't come only from the construction phase but also from transporting and producing materials. Even when the construction industry works toward innovating in many areas, they still have significant climate gas emissions. The sector accounts for approximately 16% of Norway's total greenhouse gas emissions (Grønn Byggalliansen, u.d.).

The construction industry also produces a lot of waste. The Norwegian construction industry produces around 29% of the total waste in Norway (SSB, 2021). There have been studies from, among others, The European Commission. They found that most waste produced after a building demolition activity can be recycled or energy recovered (Huanyu Wu, 2020). But the recycling and the energy recovery of materials also have climate gas emissions.

These numbers, the amount of waste and emissions that the construction industry generates, is making many companies innovate and reduce it. A way of doing this is through circular economy, which is a concept that has received more attention in recent times. Circular economy addresses responsibility toward green transformation, and it is about using the earth's resources thoughtfully and in the best possible way. There are many descriptions, but the most known is through the 3 R's: Reduce, Reuse and Recycle. Reuse is the action of using something again without changing the product.

Through this project, I will be looking at a case about reusing materials, which implements the circular economy in the construction industry. The case is Midtbygda sykehjem, located in Bergen, a pilot project for the reuse of materials. Reusing materials will reduce the amount of

waste and gas emissions in the industry, which is done by in-depth investigation of the pilot project in Bergen and some comparison with another environmentally ambitious project in Cape Town, South Africa. This research focuses on finding the drivers and barriers to the reuse of materials in the construction industry. Further, I will be looking at the learning process through the time of the project and how the organisation's construction projects can be expected to change to foster more material reuse.

1.2 Research question

The construction industry is in a transition phase, where the buildings are getting green, the requirements are getting harder to achieve, and the authorities are demanding more and more. For this thesis, I got the opportunity to follow Skanska's work with the pilot project Midtbygda Sykehjem, where they are trying to become circular by reusing materials from an old nursing home into the new one. The main idea of this project is to understand better the challenges that may appear and what makes the industry keep going on. This is then formulated with the central question and two sub-questions which are going to help to define how some barriers can be overcome:

Main research question:

“What are the drivers and barriers of reusing material in the construction industry?”

Sub question 1:

“How is the learning process when implementing the reuse of materials in the construction industry?”

Sub question 2:

“How will the supply chain be reorganised in a circular construction project?”

To answer these research questions, I used a qualitative approach in which interviews and observations were made. I also introduce the theories I use to discuss and interpret my findings. The drivers and barriers have their chapter in the theory. At the same time, I used institutional and supply chain theories to understand how the organisation in the industry works today and how this can change when implementing new methods, processes, and innovations. And to find out how the learning process has been so far.

1.3 Conditions of the study

This research study which is the final project of my master's studies, had a limited time of 21 weeks. This leads to a necessity to limit the scope of the research. The research started with a discussion with Skanska about several projects that could be interesting. That is when I decided to focus on reuse. Skanska found that reuse was a great way of implementing a circular economy in the industry. That is why I limited my master thesis, focusing on materials.

On the other hand, this master thesis is based on data collected from interviews, observations and literature focusing on one case; this limits the empirical generalizability of the findings. There was also collected data from South Africa. Still, the time for doing this was too short, I ended up having too little information compared to the Norwegian case, and the case is very different from the Norwegian. This made me decide to compare what is comparable, and the rest is open for further research.

This research project had an ample understanding of terms and processes inside of business models, technology, and manuals such as BREEAM. This also limited my thesis since the knowledge I already had was limited. This also made more accessible the decision to look at *materials* and *waste*.

2. Theoretical framework and literature review

As industries consist of, among other things, a combination of firms, institutions and networks, the green transition requires a reorganisation of several aspects, both within firms and on the broader industry constellation (Geels, 2002). In this thesis, this is approached through two theoretical tools: institutional theory and supply chain. In this chapter, I will be describing the theories I will need to discuss the findings later for the reuse of the materials. When talking about reuse, I describe it as an innovation; this is because they are developing something new. Like (Birgit Abelsen, 2013), p. 19 mentions, "*innovation means to renew or develop something new*". Innovation can be a product, a service, or a technology. In this case, reusing materials will change the whole process; therefore, it is an innovation. It will require innovation, especially organisational innovation since there are going to appear new ways for organising the construction process, but also so technological innovation.

To understand better the organisational part of the innovation, I will be using firstly the supply chain perspective, which allows for analysing how the workflow, collaboration and actors involved may change as the construction industry implements a more circular model of operating. On the other hand, the institutional theory allows an analysis of the rules (both informal and regulatory) that guide the interaction and ways of working in the industry. This, in turn, lays the foundations for identifying drivers and barriers to implementing a circular economy in the construction industry.

2.1 Institutional theory

An institution is a term that can be used in different content. In oral language, the time is often used about concrete and visible facilities such as hospitals, courts, or schools. Those are regulated through laws, state or municipal funding, management and regulations, and norms and routines. In social sciences, institutions refer to these formal and informal rules that regulate behaviour. Institutions shape standards and practices within a society; it could be the nuclear family or a father for a family. Those are stable roles that solve problems differently (R., 2002). Thus, we can say that institutions can be defined as “*cultural cognitive, regulatory and normative structures and activities that provide stability and meaning in social relationships and situations*” (Scott, 2013, s. 52). In line with this, we can say that we as individuals are actors in an institution that we call society, which consists of several institutions.

(Scott, 2013) suggests there are three institutional pillars:

- *The normative pillar* – includes norms, values and roles based on the sociological origin. There is an everyday basis for standards and values, which is moral, and this can fill the grey areas outside the laws. (Scott, 2013) p. 64.
- *The cultural cognitive pillar* – several perceptions of the world we live in. These will determine the interpretive framework we use to understand what is happening around us (Scott, 2013) p.60.
- *The regulative pillar* – formal rules which regulate behaviour based on laws, regulations, policies, and principles that include compliance with and sanctions in case of violations. (Scott, 2013) This can contribute to innovation within the various directions, which may, for example, demand from the authorities for change. As these

significantly impact many companies, they will consequently be "forced" to develop new services that meet the requirements. Meeting legal needs effectively can become a competitive advantage. An example of this is the latest environmental requirements (Scott, 2013) p.59-64.

Those are the three pillars that Scott defined, allowing us to distinguish between different types and aspects of institutions. Both formal and informal institutions will be able to give our society a structure on how we must behave in political, economic, and social environments. All three pillars are fascinating for the analysis of the project; at the same time, I will be connecting this with a later theory about barriers and drivers.

2.2 Supply chains

This chapter provides an overview of the organisation and supply chain concept literature. Supply chains are the network of organisations involved through upstreams and downstream linkages in a production network (London, 2008). Managing supply chains is central to economically efficient production (London, 2008) and environmentally efficient production (Muhammad Farooque a, 2019).

The following figure shows how the most of the construction companies' supply chain looks like, and it is an adaptation of the prior model from Poirier and Reiter. There are some generic construction supply chain activities, but at the same time, every project can have its unique procurement relationships that alter the chain (London, 2008). Examples of stakeholders that may transform the chain are contractors, clients and consultants. If the project implements new methods, they may also include actors who have traditionally been located further down in the chain or just new actors. It could be specialist subcontractors or manufacturers playing a critical role in supply chain management (London, 2008).

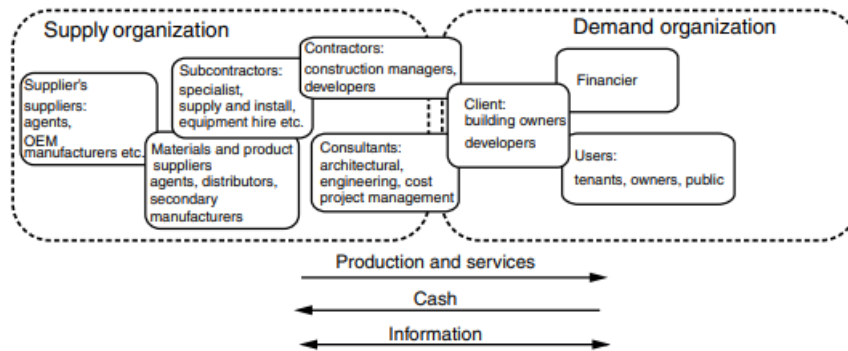


Figure 1 - Generic construction supply chains

Source: London, 2002 – article "construction supply chains chapter 3."

Another recently introduced definition is "circular supply chain management" (CSCM), which has been used many times to link circular economy with supply chain management. According to (Muhammad Farooque a, 2019), CSCM are unique because of 1) its restorative and regenerative cycles designed based on circular thinking; 2) the vision of a zero-waste economy inherent in the CE philosophy. Therefore, in this article, they propose the following definition for CSCM (Muhammad Farooque a, 2019):

“Circular supply chain management is the integration of circular thinking into the supply chain management and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste management, involving all stakeholders in a product/service lifecycle, including parts/product manufacturers, service providers, consumers, and users.” By making the loop toward zero waste and circular, it will be possible to improve environmental performance by bringing back goods and packaging materials to the producer to recover value (Muhammad Farooque a, 2019) since waste will still be a problem even in a closed-loop supply chain, as it is rarely feasible to reuse/recycle all unwanted items within the same supply chain. What a circular supply chain can do is go further and add value to waste by collaborating with other organisations. The collaborations could be in the same industrial sector or with other sectors (cross-sector) (Muhammad Farooque a, 2019). It's illustrated in the following figure.

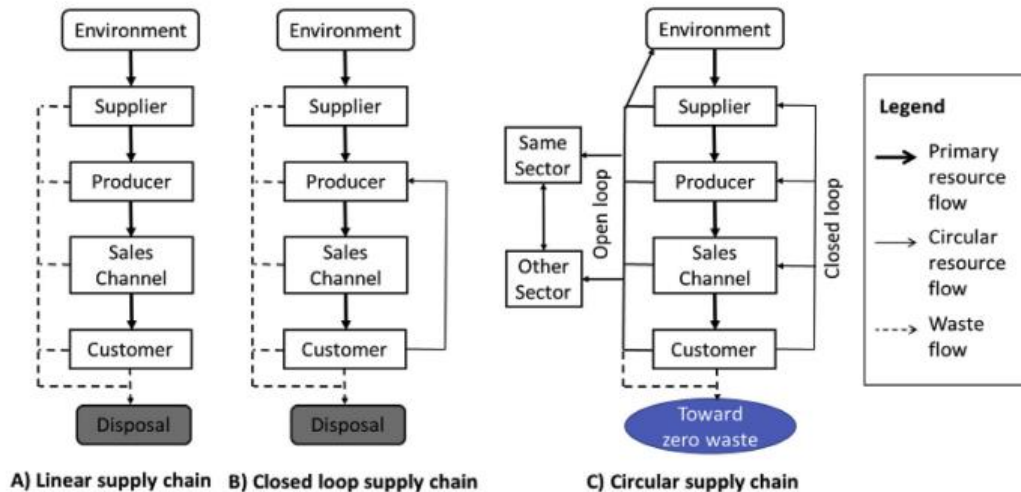


Figure 2 - Linear, Closed-loop and circular supply chains

Source: Article «circular supply chain management” (Muhammad Farooque a, 2019)

Through mapping and understanding a supply chain, will I be able to see the differences between a project where they use circular economy or reuse materials and a project where they are not. It also makes it easier to see the organisation of a project, furthermore where there might appear difficulties and barriers.

2.3 Drivers and barriers to reuse

In this chapter, I will explain the factors that affect the innovation of implementing the reuse of materials in the construction industry and what we call barriers or difficulties that may appear for companies that want to innovate. At the same time, I will identify what incentives innovative processors work with activities with the potential for making new ways to grow. Drivers and barriers to change can be found both in the firm and the broader industry/socio-technical system. Drawing upon (Isaksen, 2019), this will be referred to as the firm level and the system level (Isaksen, 2019). Barriers should be surpassed to get a better potential for reuse. That is why it is essential to research.

Abelson 2013 also said that *"although a company has motivation for innovation and development, the success behind the innovation work can be influenced by factors that often depend on the sector the company belongs to, type of innovation, what degree of innovation*

will it be representing and which markets the company operates in” (Birgit Abelsen, 2013) p.45.

Barriers are the total opposite of drivers, which means that drivers will, in this case, promote more reuse, while barriers will make it more difficult. Identifying the different barriers and drivers could find some situations that present themselves as a double-edged sword, identifying themselves as both drivers and barriers.

Despite the complexity, (Birgit Abelsen, 2013) came up with different aspects that affect companies' ability to innovate. They divided this into three sectors; the first is the *external factors*, which are at a system-level, where we can find the market, industry, competitive conditions, networks/alliances, and regulatory conditions. We can also find external factors like demand, concentration, demand growth, profitability, and geographical factors like benefits of proximity, developments of clusters and client-deliver-relation (Birgit Abelsen, 2013). The second is called the *internal factors*, also at a firm level, including strategies, company's characteristics, control and measurement systems, structure and leadership and culture. The last one is the *personal factors*, passion and endurance, creativity, idealism, competence, career, status and salary (Birgit Abelsen, 2013).

Looking back at chapter 2.1 about institutional theory, we can see a connection between this and the three pillars; when the first pillar told us about the normative, (Birgit Abelsen, 2013) the pillar can be tied to the internal factors, including values, strategies, and norms the company, etc. The second was the cultural cognitive, and we can see some similarities with the personal factors like strategies at a company level or creativity at a personal level. In contrast, external factors will go hand in hand with the last one, the regulative pillar, where we find the limitations and regulations like norms and rules.

2.3.1 Drivers and barriers in a firm-level

Some factors will promote and inhibit innovation on a firm level. It will be essential to look at the different characteristics of a company. The elements that can affect are everything from the size and age of the firm, ownership structure, budget, and other factors of the company (Nizar Becheikh, 2006). These can influence the promotion or inhibition of innovation and sustainable development (Birgit Abelsen, 2013). (Nizar Becheikh, 2006) concludes by saying that results suggest a positive correlation between firm size and innovativeness. Still, the relationship is complex, so it is wise to temper the effects to not fall into abusive generalisations. The same

happens with the age measurement; with age, a company will accumulate the experience and knowledge necessary to innovate. And the innovation from older companies could influence more than those of younger ones. But at the same time, older companies can develop established procedures and routines which may lead them into path-dependence (Nizar Becheikh, 2006).

2.3.2 Drivers and barriers in a system-level

The drivers and barriers at a system level are often affected by framework conditions and success factors for the company's innovation work. The structure of industry relates to innovation, and this may vary with the industry and sector. That is why the industry can be affected by factors like *geography, politics, resources* and more, both in a good or bad way. Also, the same factors that could be a driver in one industry could be a barrier in another. Under the geographic characteristics, we can find region; this will also influence since some sectors depend on being close to another regional innovation environment if they want to develop. Even the most prominent companies need to cooperate with others to be part of the technological development (Birgit Abelsen, 2013). Many companies don't have the capital or resources to complete all development themselves, so they enter into strategic alliances (Birgit Abelsen, 2013).

Another difficulty at a system level could be that many companies are based on engineering- and art-based knowledge. They use a larger share of tacit knowledge in innovation processes. There are forms of knowledge that are more difficult to move across geographical distances because they are linked to peoples' experiences and specific types of products and markets (Birgit Abelsen, 2013).

2.3.3 Factors that could be drivers or barriers in this project

Since the factors that may affect the one industry/company/sector are not always the same as others, Drivers and barriers to green transition may vary between different industries, sectors and companies. By seeing existing literature in light of prior knowledge about the construction industry, some factors stand out as more relevant than others. Drawing upon (Birgit Abelsen, 2013) those factors are *culture/firm's characteristics, competition/profitability, institutions, the state/authorities, and motivation*. Every one of these factors could be a driver and barrier. And

the factors that are the only barriers are *costs*, *time* and *market*. All of them will affect the system level (local environment and organisations outside the company) and/or firm level (factors within the company).

"Barriers of entry" could also be an essential factor in this case, where there is a connection with the *capital*, *technology*, and *market* (Birgit Abelsen, 2013).

2.3.3.1 *Culture, competition, and firms' characteristics as a barrier*

“*Cultural barriers concern aspects of the social, behavioural and managerial contexts in which the CE is required to develop, such as the entrenched nature of the linear economy*” (Jim Hart, 2019) p.621 is mentioned in the article about barriers and drivers in a circular economy. These factors affect both firms, the whole industry and the collaboration between firms. (Jim Hart, 2019) divides those barriers into several sectors, saying that, for example, the lack of interest, knowledge/skills and engagement through the value chain can make innovation more difficult. It can be all from suppliers, customers and internal. At the same time, the collaboration between businesses and business functions is crucial for making it possible. The lack of interest is probably one of the biggest problems; this leads to a lack of progress and slows down the development of a potential building material's reuse (Kanters, 2020). At the same time, the competition may lead to a lack of collaboration which ends up being a barrier known as "silo mentally" when businesses can't work together openly to achieve a common goal (Jim Hart, 2019). And at the same time, as there are problems with the collaboration between businesses, it's also often a lack of cooperation between sectors. The construction sector is a conservative industry, which means that the industry is used to doing the same repeatedly.

2.3.3.2 *Culture, competition, and firms' characteristics as a driver*

The collaboration between firms will promote the development; instead of working in different directions to get to the same place, it is greater to work together. With time it will be imaginable for businesses to work together as partnerships and form long-term relationships (Jim Hart, 2019).

At the same time, as competition is a barrier which separates businesses, it can also make the companies encourage and promote green images of companies. As they can collaborate with methods to get better, they might also develop new ways since every company is different.

Competition "*can, in other words, be reflected in a new and improved product, service or process, where those companies that can develop and/or adopt new technologies and methods, can achieve an improvement in competitiveness*" (Birgit Abelsen, 2013) p.50, author's translation). Being the first company to challenge themselves and make possible new ways to implement green transformation and circular economy in the construction industry is a competitive advantage.

2.3.3.3 Profitability as a barrier

When innovating, there might appear different factors affecting the processes. Some risks will be taken in innovation projects, long gestation periods, and often it ends up requiring vast amounts of financial resources (Joseph Evans Agolla, 2016).

(Jim Hart, 2019) mentions 1) **High upfront investment costs** and 2) **low virgin material prices** among the barriers to a circular economy. These two are directly related to profitability as a barrier since today it is cheap to buy new and raw materials, and innovation often leads to an upfront investment at the start of the process. At the same time, there are **limited funding** and **poor business case** since material reuse is new. What makes it difficult is that you cannot compare with previous issues since there are not. No prior expertise or experience and the market doesn't know the product/method, and therefore no demand. This is directly related to the construction industry. This gives us a bad business case which is linked to new processes or innovations, that is because it is difficult to compare with older experiences. The market is not developed, which is defined in chapter 2.4.3.8.

As a financial barrier, we also include raw materials, property ownership, and investment. One of the most significant barriers in this sector is the **low virgin material prices** and even lower end of life values, particularly in the built environment, because of the uncertainties about value in the distant future (Jim Hart, 2019). At the same time, there are not many studies, **poor business cases and unconvincing case studies**. The business and environmental cases are insufficient and incomplete. And there is **limited funding** (Jim Hart, 2019).

2.3.3.4 Profitability as a driver

Chapter 2.3.2 mentions how the competition can enable or give strength to making innovation possible. (Schumpeter, 1934) said that innovation is the most important way a company

compete, and it is because they want to offer something better and different from other companies. When every company starts showing the same will, new processes appear, making the process more fluent and effective, leading to fewer costs. Many innovations begin because the companies see a financial profit in the end.

As discussed further in chapter 2.3.3.2, developing the necessary skills and infrastructure for material reuse might also improve profitability if regulations change, the market for reuse increases or virgin material costs increase.

As financial drivers, we can also find that the life cycle costing and new evaluation techniques incorporating environmental, social, and political sectors may increase the emphasis on the asset value of the materials (Jim Hart, 2019). Something that could drive more innovation for a circular economy, in this case, reusing, would be increasing the costs of landfilling waste (Chileshe, 2016).

2.3.3.5 Institutions, the states, and authorities as a barrier

(Jim Hart, 2019) mentions three main barriers when talking about regulatory obstacles. The first is the **lack of a consistent regulatory framework**, including an absence of global consensus around policy support for the circular economy. The second is the **obstructing laws and regulations**, many laws and rules worked at the right time, but when innovating, we should be changing them. The authorities have significantly regulated the construction industry; this is mainly because of the safety and environment. Following the rules when innovating, like with circular economy and reuse, can be challenging since they fit the old way of constructing and are not taking care of the new procedures. The last one **lacks incentives**, which the most frequently mentioned are public procurement and tax incentives, and producer responsibility.

2.3.3.6 Institutions, the states, and authorities as a driver

Requirements from the outside world or regulatory conditions can force companies to innovate, develop new products or services or new production processes (Birgit Abelsen, 2013) p. 52. (Birgit Abelsen, 2013) give us some examples of requirements and conditions that can affect the industry through clients' and suppliers' opinions; those are *accounting rules, environmental needs, safety, technical requirements or health requirements*. Explaining the most relevant for my case:

1. *Environmental requirements* are related to both national and international rules and conditions. An example is the new requirements for reducing CO₂, leading to new innovative technologies, new products and new industries (Birgit Abelsen, 2013), p.53.
2. *Safety* is related to health, safety and the environment, essential goals for every company and industry. An example is to reduce the number of people on the drilling deck on offshore oil rigs, which leads to new products and processes (Birgit Abelsen, 2013)

(Jim Hart, 2019) also mentions three factors that are enablers or incentives. First is **the policy support**, which "*is recommended for skills and innovation, and metrics for circular economy and embodied carbon*" (Jim Hart, 2019). **The regulatory reform** is an enabler to looking at obstructive regulations. And the last one is **incentives** for the innovation, including fiscal incentives and reduction in VAT when possible.

2.3.3.7 Motivation as a driver, while lack of motivation is a barrier

There is a remarkable agreement that personal driving forces are among the most critical reasons for creativity and innovation (Birgit Abelsen, 2013) p. 61. (Birgit Abelsen, 2013) came up with a division of the person driving forces (1) **the internal or individual factors** where we can find self-motivation and inner driving force for innovation. The dictionary gives us two definitions of motivation:

1. *a reason or reasons for acting or behaving in a particular way,*
and
2. *a set of facts and arguments used in support of a proposal.*

And (2) **the external or social factors**, where there is a need for external motivational factors or incentives to maximise the internal motivation and/or driving force. Passion is an excellent example of the first one, and it is shown to be a significant driving force for innovation (Birgit Abelsen, 2013). While the externals are, for example, salary, this can be an incentive to work harder, or on the other hand, stop working because it doesn't give anything in return and end up being a barrier.

2.3.3.8 Barriers: time and market

The other barrier is the *time*; the construction industry is conservative, the industry has worked and done the same steps for years. Innovating in this sector often leads to changing the steps and taking more time to get to the results. Time is directly connected with costs; when a process takes longer means more use of expenses in working hours. At the same time, the industry works with deadlines that frequently cannot be moved. (Gorgolewski, 2008) said that “*the low cost of construction materials and the high cost of labour required for the dismantling process have made the economics of reuse uncompetitive in many cases. Also, the established design and construction processes make reuse more difficult to integrate since they rely on readily available standard materials.*” (Gorgolewski, 2008). Having to reorganise and find new ways to make the construction ends up using more time, which the construction industry finds challenging already.

And the last one is the *market*; it can help with a push or make it impossible when there is no market. When talking about the impulses, we can differentiate between a “*technology-push*” where the innovation is driven by a company or industry or a “*demand-pull*” where the clients are challenging (Birgit Abelsen, 2013) s.49. When there is no market, there is no innovation. Even if the industry comes up with a good idea for a product/process, it will be complicated to make it work without a market.

2.4 Theoretical framework - summary

The main goal of the theoretical framework was to show that my work is grounded in established ideas. During this chapter, I explored different theories and models to find the most relevant to present and explain the information needed.

Now that I have presented the theories, I want you to understand how I will connect them all. I decided to base my studies on three main theories; where the first was the institutional, followed by the production network and the last barriers and drivers. All of them are connected. A production network, which is one main organ of industry, will not be able to work without the institutions and regulations that are found in the institutional theory. I will be using this theory to discuss and identify different actors and collaborations between companies and systems/the industry. The institutions will guide my project to understand how changes may

occur in a company and the country—knowing that reusing materials is a new way of thinking and working in a construction company will change the supply chain. At the same time, the institutional and the production network theories are directly and indirectly the foundations for barriers and drivers for implementing the reuse of materials in a construction project.

By looking at institutions and production networks theories, we can already see where some barriers may appear, but also some drivers. I wanted to have it as my last chapter of the theories; the institutions and supply chain are the foundation for the barriers and drivers. And barriers and drivers are the main questions I want to answer during this project. The supply chain makes the organisation of a project easier to understand, as they include contractors and the whole process. At the same time, the three theories explain how a company works and how a learning process could appear or where can be difficulties.

3. Methods and research design

In this chapter, I will review the method used for conducting and planning the study. Research and techniques used for data collection, how the collection was executed, and the study's sample strategy will also be presented here. In this case, the method I chose for doing the research is a qualitative study together with a case-study research design. This chapter will describe why I have chosen those methods and how they are implemented. Moreover, it will be mentioned the analysis process, as well as the study's validity and reliability.

3.1 Choosing the method and research design

The research design involves organising the collection of data so it becomes possible to achieve the goals of the research. This often covers three main questions; the first is about what is to be researched, *how* this is to be carried out and from *where* data can be obtained (Easterby-Smith, 2018) p.91. Further, this means that the research design addresses the task of having an overall plan for the research part where it is explained how the chosen topic and problem are to be answered.

The empirical phenomenon I wanted to investigate in the master's thesis is the following:

"Reuse and circular economy in the construction industry"

To investigate the introduction of material reuse in the construction industry, I have chosen to use a qualitative method. By this, I mean research that goes in-depth also to get information about people's attitudes and thoughts. This type of method is well suited for examining questions about *what, why* and *how*.

Through the study, it was relevant to continue a form of *constructivist epistemology* in which the study is interpreted to maintain a broader view and deeper understanding of the situation in the industry. Epistemology should describe rational thinking or find conditions for knowledge and science. This has two main directions; during this thesis, it is used constructively because it is a more *interpretive* method, then it is likely to find truths in a person's eyes that it's not possible to find otherwise. This method deals with data collection methods such as interviews, document analysis and participatory observation, where it is possible to observe the whole context. The method is concerned with interpreting actions, speech and text and focuses on processes and dynamics. Constructivists will search for connections based on questions and, at the same time, have a case approach to seeking awareness (Easterby-Smith, 2018) p.71. A qualitative method uses open-ended questions instead of predefined ones and will ensure an exploratory approach (Easterby-Smith, 2018) p.173; I will also use qualitative case study research to achieve credibility with several sources of evidence.

Thus, I decided to have a case-study design with one main case and a second sub-case I will be comparing. The main one is called the Midbygda Sykehjem project, located in Bergen, Norway; the second is called River Club Project in Cape Town, South Africa.

At the end of the chapter, I will also explain how I worked with the data I got before entering the analysis.

3.1.1 Comparative method

I got the opportunity to do research and collect data in South Africa. I found out that the best way to include this data in my project was by comparing cases. This would allow me to get a good foundation for the empirical part of the project; it works by using retrospection.

I wanted to understand where could appear difficulties when implementing methods for reuse in the construction sector. Norway and South Africa are different countries with different histories and institutions. I thought that they might work differently when innovating. I screened a large construction company in South Africa for comparable projects. The projects

in their portfolio were quite different from the Midtbygda case. However, there was a project that lent itself to shedding light on various aspects of material reuse and other parts of the construction process. Combining and comparing data from one Norwegian and one South African case thus gave me a better understanding of the ground problems that can appear.

Comparing two different cases, and finding similarities and differences, gave me a great understanding of the ground problems that can appear while implementing these kinds of innovations.

“A comparative structure repeats the same case study materials two or more times, comparing descriptions or explanations of the same case.” (Yin, 2014) p.188. The repetitions of those findings illustrated a pattern-matching technique; when repeating a similar set of episodes, the credibility increase. (Yin, 2014) p .188. My cases are different; nevertheless, I found that comparing some aspects of the two instances gave a better understanding of the factors that affect the reuse of materials in the construction industry.

3.2 Case-study

When the boundaries between the phenomenon itself and the context are unclear, one can use a case study. This type of study is defined as an empirical method in which it examines a current phenomenon in-depth and indicates the context (Yin, 2014). Case studies are also suitable for investigating in depth how certain phenomena and processes play out. They are thus a practical approach to gaining better knowledge of new phenomena or developing new and refining existing theories.

Based on the problem of uncovering drivers and barriers to reusing materials in the construction industry, it is natural to ask how and why questions; thus, it is appropriate to use a case study as a research design. In addition, the circular economy in the construction industry is still in the pilot phase, where they are experimenting with solutions. For it to be possible to use case study research, the phenomenon must exist today and be observed directly, in addition to having the opportunity to interview people involved in the events/phenomenon (Easterby-Smith, 2018).

Furthermore, the *embedded case study design* is relevant when the study consists of several integrated analysis units, either in one specific case or several cases. On the other hand, we have so-called *holistic case studies*, where we focus more on studying the whole of a company

since you cannot identify logical analysis units. In this master's thesis, I explore the phenomenon at several different levels of analysis in an organisation, as mentioned in the chapter above; this is a so-called *anchored single case study design*. Here, both *observation* and *interview* were used to collect relevant data at both the management level and employee level.

3.3 Case and interview selection

The leading case will be the project in Åsane. In a case study, you often go in-depth on one or a small number of companies, and you can choose between carrying this out using a single case or looking at many instances. In my study, I have decided to use a simple matter as I wanted to look at the whole case and thoroughly research a specific project. At the same time, I compared the data I got in South Africa from the project in Cape Town. Moreover, there is also a project in Oslo in which they reused materials. I also compared and introduced some strategies from that case to empower my project and make the findings more credible. Since most of my data is from the project in Åsane, I concentrated on working with Skanska and tried to get the most of my referents from this project.

When collecting data is necessary to be accurate for proper analysis. Therefore, the information was collected during the first two months of the project. The data is gathered from articles making possible the theory chapter, several interviews, and observations. This ended up being ten articles and three books only for the theory chapter. More books, articles, websites and several documents I got from Skanska and WBHO, seven interviews and four observations were the collected data for the rest of the project. The collected data is carried out over two projects. The one in Norway is a pilot project called Midtbygda Sykehjem; professionals working on and involved in these projects, such as engineers, owners, architects, and other professionals, were the informants from the interviews. The second project is RCP (River Club Project) in South Africa; the collected data is from documents, one interview and one observation.

Data were collected at the company level in Skanska's construction group; simultaneously, I got some interviews with people involved in the project but from other companies. There were studied two different levels of analysis in more detail. These levels of analysis were respectively at *the strategic management level* (group and project level) and individuals at the *skilled worker level*. Examples of relevant informants at a management level could be a

regional director and director of the strategy and business development at a group level, as well as project owner and project manager on the specific construction project. These informants provided relevant information about the overall strategy and development plans in the group, as well as a more detailed overview of construction and zoning plans for the new nursing home in Åsane. At a skilled worker level, the workers on the construction site were relevant informants who provided further information about, for example, work routines around reporting and recycling. Since the informants signed a paper for being anonymous in the thesis, I will not name which roles they had in the project. That is why I gave examples of the levels.

During this chapter about the methods, I wrote about who, how and why I interviewed, explaining the technical part of the interview. I wanted to interview the informants from a management level because they are the ones who will introduce the new measures in the construction process. I questioned how they intend to implement such concepts and strategies so that everyone is aware of what is going on. I also wanted to know what motivates them and how they will act if difficulties appear. At the same time, I tried to perform a participatory observation where I was looking forward to walking around the construction sites and doing an inspection. The goal was then to see how works the implementations I talked about during the interview part. As the case projects were in an early stage, it was impossible to study the entire process of implementing reuse. Also, the cases were very different, they are implementing methods in different directions, and the companies work at various stages of the projects. Yet, the inspections gave me a better understanding of implementing innovation; since the Midtbygda project was in a very early stage, it was great to see something getting built in the RCP. At the same time, the RCP came with excellent implementations of the discussion and findings.

With this, I could better understand how it implements new processes aimed at green innovation, such as the circular economy and reuse on the construction site.

3.4 Method and data collection

During this master's thesis, I have chosen to use a qualitative method. I mean research that goes in-depth to get information about people's attitudes and thoughts. This type of method was well suited for examining questions about *what*, *why* and *how*.

Two methods were used for collecting data, “*in-depth qualitative interview*” and “*participatory observation*”. The first, called *qualitative in-depth interviews* gave me the possibility to go in-depth; I wanted to conduct in-depth discussions on managers and people who work actively on the construction site. Here was it necessary to have an interview guide, but the interview itself was semi-structured, where I followed it with some flexibility. It was also a focus group interview since the group was determined. In addition, I was making some participatory observations on the construction sites where it was possible to see and understand from another point of view. Finally, I was also collecting data from a secondary source where there were discussed themes related to a circular economy, waste, reuse, and other relevant topics for my project. At the same time as Skanska gave me access to reports, etc. Therefore, we can say that I performed a *method triangulation* to collect data for the study as the research design is a greater diversity of methods, getting data from different sources.

When conducting an in-depth interview, it is important to have an interview guide and some questions listed to have something to follow and angle the discussion towards what you have as a goal. To be prepared, *secondary data* had to be in place, read and understood. We call secondary data information about similar or similar research that already exists. These have been collected by other researchers for other purposes and are usually in publications, reports, etc. (Easterby-Smith, 2018) p.173. They are presented under the chapter about theory. The data I have collected came from several reports, documents, projects, and books, at the same time as I collected data for the background chapter later in the project from other sources, reports, documents, books, and websites.

There are several advantages to using secondary data, such as the fact that it saves time and the data sources are often of high quality. However, one must be critical of data collected by others to assess how credible they are. I used secondary data to see how reuse and circular economy have been introduced in other projects and to overview technical reports and working procedures already completed in the Midtbygda Sykehjem project. After becoming familiar with the secondary data, I prepared an interview guide for the qualitative interviews.

I wanted to have most of the interviews physically, but since some of my referents were in other cities, I had to have some digital. I ended up having a total of seven interviews and four observations. Three of the interviews were physical and four digitals. The *observation* was my second method for collecting data, in which I participated observing but without interrupting. This kind of observation is called “*participatory observation*”, in which I was engaged in the

field in a relatively passive way. It means that I was observing but not interacting; the only cases I participated in were when they asked me something or when I felt that something was unclear. The observations were two inspections of the construction sites, one in South Africa and one in Norway, one workshop and participation in a meeting in the Norwegian case.

While I was at the construction sites, I did talk with several different actors that were a part of the projects, while observing with my own eyes gave me a visual understanding of how it works and the complexity of the project.

3.4.1 Analysing the collected data

After collecting my data, I had to process it and work on it so I could search and find quickly the most relevant out of it. I ended up with seven interviews and four observations, and I also had many meetings with Skanska.

	Company/Organization	Role/Work area
Informant 1	Skanska	Engineer
Informant 2	Skanska	Climate and environment
Informant 3	Nordic Architecture	Architect
Informant 4	Bergen Kommune	Engineer
Informant 5	Bergen Kommune	Engineer
Informant 6	Resirqel	Architect
Informant 7	WBHO	Engineer
Informant 8	WBHO	Lawyer

The informants were approached via e-mail; I got a list of relevant people I could contact involved in the projects I write about. The average duration of the interviews was around an hour, not less than 50 minutes and the people I chose to interview were based on their roles in the projects. I interviewed the main actors involved in the project, with activities directly related to my research. They were from different companies and with diverse roles.

When analysing the data, it is essential to avoid missing delicate information in the collected data. It is easy to rely heavily on my opinions and judgements and be subjective to the data. That is why I ended up searching for a way of understanding my data and working with it, and

I found the thematic analysis a good way of doing it. The thematic analysis is based on: (Caulfield, 2019)

1. Familiarisation – getting an overview and understanding of my data. Involves transcribing audios, reading articles, and taking initial notes. That's where I started, so go on and have the interviews and do the transcript.
2. Coding – also highlighting the sections of my text so I could use them later to describe the content. For doing the coding, I used the program named Nvivo12. I had, in total, nine principal codes, with several under-codes
3. Generating themes – when looking at the codes I made, it was easier to identify patterns among them and start coming up with melodies.
4. Reviewing themes – here is where I took a new look at the themes I chose, making adjustments to make sure that our themes are excellent and accurate representations of the data.
5. Defining and naming themes – defining and formulating so they help the project understand the data. Here was essential also to be careful of the main questions I wanted to answer; the themes had to be related and answering those questions.
6. Writing up –in which I finally started writing. I was done with decisions and started analysing. When analysing, it was essential to use the theories and the interviews to describe the findings—and finally, get conclusions.

3.5 Validity and reliability

When doing a research study like this is important to know if the study is conducted in a "good" way. In qualitative research, this is often understood as internal validity and reliability (Yin, 2014).

Validity is to be able to draw valid conclusions and, thus, generalise based on the results of the study. When talking about validity, it refers to how accurate the results are based on the method used. The more valid, the more precise the results are, and then they will correspond to natural properties, characteristics, and variations. We can divide this into two, the internal and the external validity, where the intern is how the researcher sees the reality and how they match with the truth. This is generally reached by anticipating questions that begin dealing with the overall problem of making inferences, such as "*have all rival explanations and possibilities been considered? Is the evidence convergent?*" (Yin, 2014) p. 47. Meanwhile, external validity

is obtained by seeing if the findings from the research can be used in other situations."...*deals with the problem of knowing whether a study's findings are generalisable beyond the immediate study, regardless of the research method used.*" (Yin, 2014) p. 48.

Reliability will qualify the results and articles, telling us if they are trustworthy or not. This will let us know if the results are valid. It also tells us how easy it is to replicate the researchers' findings. Also, if another researcher does the same study with the same methods and procedures, will he be able to recognise the conclusions (Yin, 2014). With that, we can be sure that there are a few failures as possible, "*the goal of reliability is to minimise the errors and biases in the study*" (Yin, 2014) p. 49.

In a qualitative study will, the researcher often goes into detail and does a more in-depth study; after that, a better understanding of the studies contributes to good reliability. I used a triangulation method which leads to more validity since I used several articles from different researchers, different data collection methods and background materials. Cases with little research will have a higher risk of getting too many perspectives and therefore not getting any final answer. That happens because some critical theoretical dimensions can be excluded or forgotten from the study. Still, the goal is to understand better how the transition to a circular economy takes place. This is something I consider when I analyse.

4. Background for the study

This chapter describes different important backgrounds for the empirical background and understanding of this thesis. The first section of this chapter provides a backdrop of the green transformation to which material reuse should contribute. This is followed by a presentation of current knowledge on the green shift in the construction industry. Further in the chapter, we find the circular economy definition and how this is implemented of ment to in the construction industry.

Then, I also define why the waste is the central part of the project and what is so vital about it before jumping into the description of the cases I wanted to study. This is also the last chapter before analysing and discussing the findings, so the idea is to give a background for the study.

4.1 Green Transformation - political goals and climate agreements

As a response to climate change in 2016, the European Union set a goal of becoming a low-emission society to deal with climate change. Every country in the EU had to develop their requirements for dealing with its climate gas emissions (FN, 2020).

Norway has distributed these goals in several sub-goals. The first one was to cut down climate gas emissions by 30%. The next sub-goal has a deadline in 2030 when 50-55% of the emissions will be reduced. Moreover, in 2050 will we be climate neutral. Climate neutrality means that climate emissions sent to the atmosphere are not more extensive than what we manage to capture or remove (FN, 2020). These agreements were put under the Paris Agreement adopted in 2015 and entered into force in 2016 (FN, 2020). The Paris Agreement is an international agreement that ensures that countries can limit climate change.

This lays the foundation for why several companies have turned their hats and decided to innovate toward a greener future. Norway has decided to go for a green transition driven by sustainability and digitalisation. Two relatively new events have intensified this change in the Norwegian industry and business: the corona crisis and the oil price (SINTEF, u.d.).

3.1.1 Green change in the construction industry

There are studies from 2015 that confirm that around 40% of the total energy use and climate gas emissions in the world come from the construction industry (Dragland, 2015). When calculating how much the construction industry is responsible for greenhouse gas emissions, it is vital to consider that it is not only the energy from the energy sector that affects how much the buildings need. When buying products from industry and transport, greenhouse gas emissions are added; these are the indirect emissions (Grønn Byggalliansen, u.d.).

As 90% of the energy used to operate and heat buildings in Norway is renewable, the Norwegian construction, civil engineering and real estate sector has lower greenhouse gas emissions than the industry globally. The industry accounts for approximately 16% of Norway's total greenhouse gas emissions (Grønn Byggallianse, u.d.). These emissions come not only from energy use in buildings, which has traditionally been a focus area, but also from the production, materials and transport involved in constructing buildings (Grønn Byggalliansen, u.d.).

(Grønn Byggalliansen, u.d.) Mentions five measures the construction industry can take to halve construction and real estate emissions. The climate cure they propose is:

1. To demolish less.
2. To reuse more materials.
3. It is choosing solutions and construction products that provide low emissions from a life cycle perspective.
4. To demand 100% fossil-free and soon completely emission-free building and construction sites.
5. To make energy more efficient in existing buildings.

By ordering low-emission materials and requiring fossil-free and eventually emission-free construction sites, we will be able to reduce emissions by more than 5 million tons of CO₂ per year (Grønn Byggalliansen, u.d.).

This encourages construction companies to work toward a green change, and giving them a list of what will make the significant change for reducing CO₂ emissions makes it easier to know which way they should go.

4.2 Circular Economy

"If everyone in the world uses as many resources as Europe, will need 2.8 globes to cover consumption" (SINTEF, u.d.). The circular economy is a concept that addresses a responsibility towards a green shift. The circular economy is about using the earth's resources thoughtfully and best possible way. This is the primary goal of giving the product value and ensuring long-term sustainability. As the term mentions, one can imagine a circle without an end. The idea is that materials should be used repeatedly and not become waste. At the same time, I try to ensure that today's waste will become raw materials in the future. This will require us to use renewable energy sources and raw materials. According to the British charity, the circular economy is *"a visionary model of an environmentally and socially sustainable economy that is 'restorative by design', aiming 'to keep products, components and materials at their highest utility and value.'*" (Crocker, 2018).

The main point of a circular economy is that the use of resources must be optimised to form a closed material cycle where it becomes possible to slow down material circulation by recycling products. A circular economy changed today's consumption pattern, where products follow a

linear economy (Leising, 2018). Linear economy means that we get resources for used products until they are no longer usable (Kommunesektorens interesseorganisasjon, 2018).

The literature will circular economy appears through three main actions, often known as the 3Rs rule (Patrizia Ghisellini, 2016). Those are the principles and implementation of a circular economy worldwide: Reduction, Reuse and Recycle. With time they have developed to be many "Rs" the figure below illustrates the complex actions and stakeholders that are needed to move from linear and become circular (Srinivas, 2021). Scholars today recognise 9Rs: Reduce, Repurpose, Reuse, Repair, Refurbish, Remanufacture, Resynthesize, Recycle and Recover (Zhang, 2022).

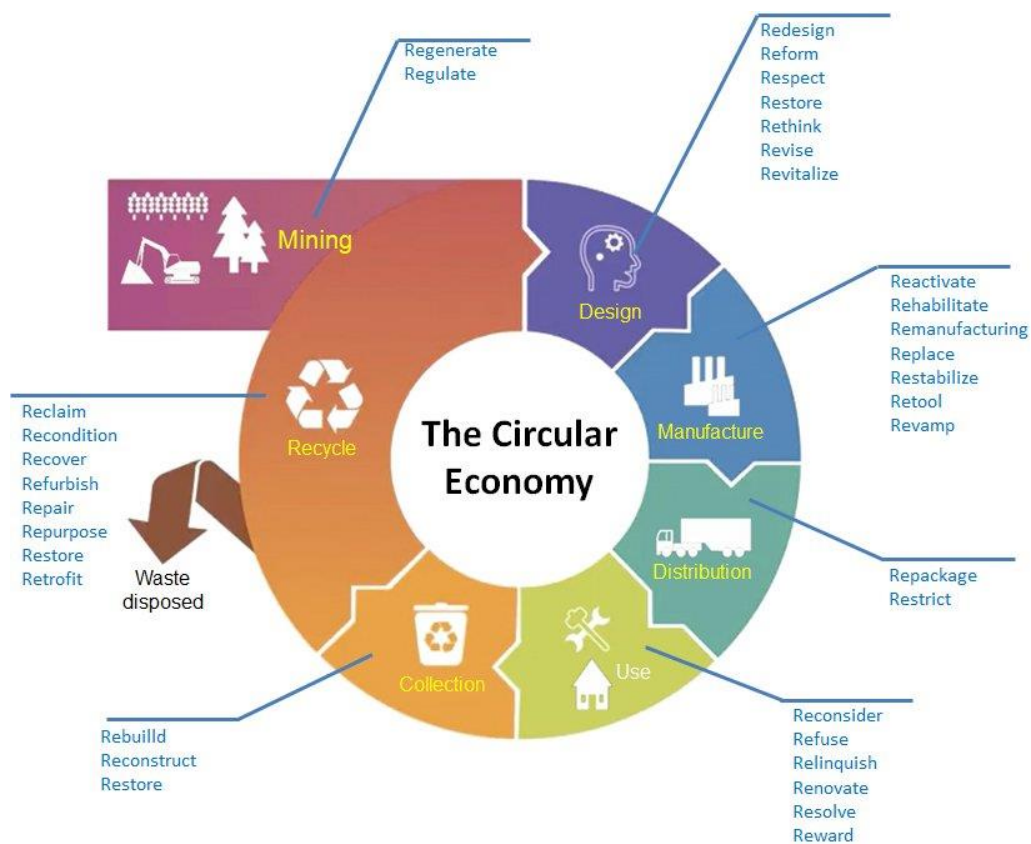


Figure 3 - The Rs of a Circular Economy

It is a closed-loop system in which the lifecycle of products and materials will keep going ensuring that we produce less waste, pollution and emissions and at the same time use less energy.

4.2.1 Circular economy in the construction industry

(Leising, 2018) writes in the article, "*Circular Economy is an economic and industrial system where material loops are closed and slowed, and value creation is aimed at every chain in the system.* It turned out that the construction sector consumes 40% of materials that are part of the global economy. At the same time, it is estimated that only 20-30% of these materials are recycled or reused after the material's life cycle ends (Leising, 2018).

Under the subchapter on green transformation in the construction industry, five measures were mentioned that can make the industry reduce emissions. The first three points deal with what is crucial if you want to use a circular economy in the construction industry.

The first point concerns demolishing less; (Grønn Byggalliansen, u.d.) says that far too many buildings are destroyed annually, and large amounts of resources go into the suction. The companies are then challenged to rebuild and try to use as much of what already exists as possible.

Point two is to reuse more materials. Reusing means to reuse without changing the material or product itself; use it as it is with the properties it already has. This is important as one of the largest sources of emissions from construction and real estate is the production and transport of materials. This can also save projects on material costs (Grønn Byggallianse, u.d.). The interest in reuse is growing and growing in the construction industry. This is because reusing building materials will increase sustainability (Direktoratet for bygg kvalitet, 2020).

In addition to reusing materials, reducing the amount of waste and recycling a more considerable portion of waste generated are considered central measures to achieving our national goal to reduce waste in the construction industry (Direktoratet for bygg kvalitet, 2020).

Circular economy is trying to see which kind of waste can be reused, and change the way we see waste so we can minimize it. At the same time as it is about remaining in the higher level of the waste hierarchy. This leads us to the next chapter, which is waste hierarchy and management, and understanding of waste.

4.3 Waste and waste hierarchy

Waste is defined as “*any substance or object which the holder discards or intends or is required to discard*” by The Waste Framework Directive (EUR-Lex, 2008). Waste for us humans is the rest of the material, and the unwanted part is discovered after a process is completed. It could,

for example, be the leaves of the strawberry after its eaten. Alternatively, materials that, after the construction or renovation processes have been completed, have nothing to add. The construction industry is the largest source to waste in Norway, producing 20% of all waste generated in Norway (SSB, 2021).

Table 1 - Total amount of waste in Norway in 2020 by "Statistisk sentralbyrå" (SSB, 2021)

Updated: 8 December 2021

Next update: Not yet determined



Download table as ...

Waste account for Norway, amounts of waste by source of origin			
	2020		Per cent change
	1000 tonnes	Share	2019 - 2020
Source of origin, total	11 596	100	-5
Manufacturing industries	1 815	16	-3
Construction	3 329	29	4
Service industries	1 517	13	-30
Households	2 546	22	4
Other or unspecified	2 390	21	-5

Since waste has been a problem that our planet is paying for, there has become more common to set up ideas and methods to reduce or prevent waste. One way to describe it is with the waste hierarchy, as we see in the following picture.






	Stages	Include
	Prevention	Using less material in design and manufacture. Keeping products for longer. Using less hazardous materials.
	Preparing for	Checking, cleaning, repairing, refurbishing, whole items or spare parts.
	Recycling	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste; some backfilling.
	Other recovery	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste; some backfilling.
	Disposal	Landfill and incineration without energy recovery.

Figure 4 - A diagram to describe the waste hierarchy (CORY Group, u.d.)

“The Waste Hierarchy ranks waste management options according to what is best for the environment. It prioritises preventing waste in the first place.” (CORY Group, u.d.).

After prioritising waste, can we find preparing for, followed by recycling, another recovery, and the least we should do is disposal. What is included in all of them is explained on the right side of the figure. Reusing, or being part of the circular economy, are the two first mentioned and the most favourable options.

4.4 What does reuse mean?

“The driving factor of waste hierarchy should not only be the environmentally sound disposal of waste but also ensure that the value of resources is preserved.” (Zhang, 2022). A way to ensure the value of the resources is by keeping them in a loop, as in a circular economy way of preserving products.

In chapter 2.1, I mentioned the 3Rs rules for circular economy in which the second rule is reuse. Reuse refers to *“any operation by which products or components that are not waste are used again for the same purpose for which they were conceived”* (Gharfalkar, 2015). Reusing

materials and products may help the environment by requiring fewer resources, less energy, and less labour compared with manufacturing new products from new and virgin materials.

4.5 Waste and reuse in the construction industry

The waste after building consists of primary materials like concrete, wood, bricks, metals, glass, plasterboard, asphalt, timber, and some plastics (Huanyu Wu, 2020). Most of the material waste produced after a building or demolition activity can be recycled or energy recovered, except for some **harmful** and mixed waste fragments (Huanyu Wu, 2020). In the past years, the construction industry has used a lot of time and resources to improve recycling, while reusing is a newer and less expertise area. While recycling is giving the product or material a new life after being processed, reusing will make the fabric go through stages such as cleaning (or not) without them having to be reprocessed or broken down to pieces.

The following figure explains the hypothesis of how different aspects affect the behaviour and the sustainability concept, where the factors are divided from H1-H4. H1 are the stakeholders that, by their actions will affect the CDW (construction and demolition waste). Those are head contractors, consultants, and sub-contractors. H2 says that the CDW within project life cycles will also affect the CDW management hierarchy. And it is divided into the three phases of the project planning and design, procurement and construction and demolition. The three next are environmental issues, economic matters and social aspects, which lead to what they call impacts of sustainability criteria, H3. The last one includes applying digital tools, approaches, and technologies; this is called the construction and demolition management tools. Then the last one for making the CDW more compelling is what we call the CDW management hierarchy, where we find reduce, reuse, and recycle. Therefore, it is hypothesised that CDW management hierarchy affects effective CDW management.

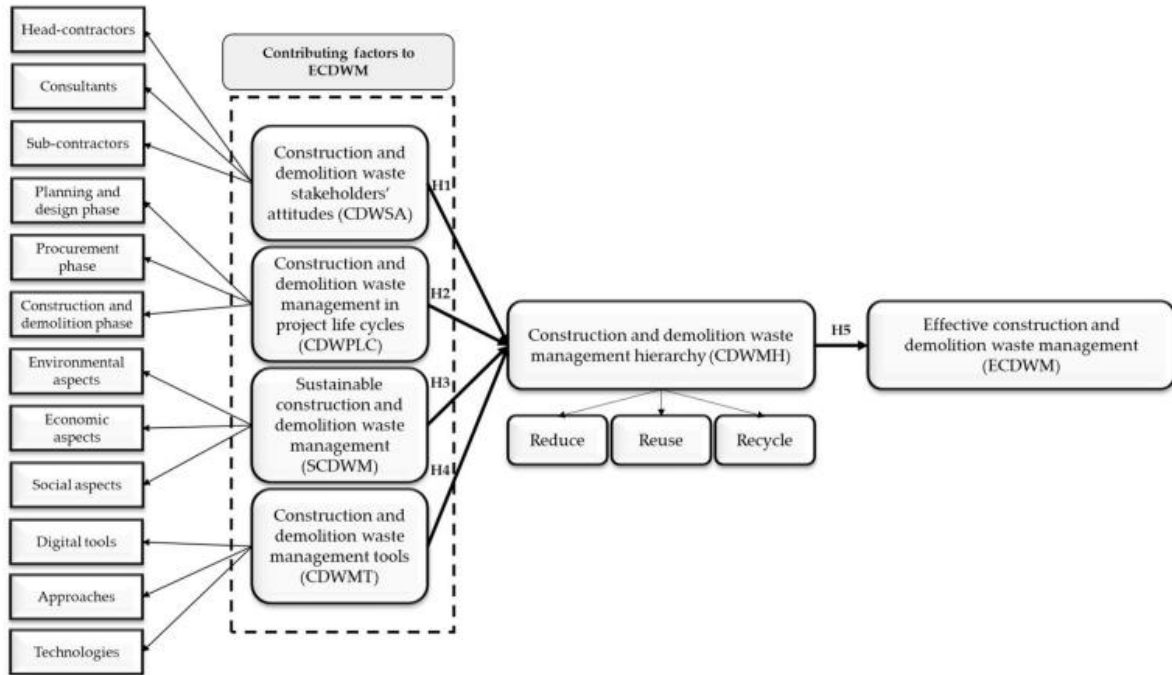


Figure 5 - The conceptual framework of practical construction and demolition waste management (Kabirifar, 2021)

The article concludes with a positive result showing that three contributing factors to effective CDW management, including H1 (CDWstakeholders attitudes), H4 (CDW management tools) and H3 (sustainable CDW management), while H2 (CDW management in the project life cycle) has shown to be ineffective on the CDW management hierarchy and therefore needs more attention from the stakeholders to consider planning and design, procurement, and construction and demolition phases in their CDW management plans. It also concludes by saying that the government should defend relevant stakeholders for CDW management in its policy. As well as assign relevant stakeholders to it in construction projects from the start to demolition.

4.6 Empirical background

As mentioned before, I have two cases. The first one is in Bergen, Norway, called Midtbygda Sykehjem. The second one is in Cape Town, South Africa, and since the name must stay anonymous, we agreed to call it for River Club Project.

Before presenting the cases, it is essential to remember that there are differences between them and the situation, culture, etc. Those differences are in the way of working, the goals of the project and the company's life cycle in the project. Both have the responsibility of collaborating with subcontractors.

At the end of the chapter, I will also present the two certification methods described by the companies used for certifying if a building is green and at which level. Those are BREEAM in Europe and Green Building Council Certification in South Africa.

4.6.1 Midtbygda Sykehjem project

Midtbygda Sykehjem is a collaborative project between Skanska and the municipality of Bergen. The project is developed and will be demolished and built by the same company, Skanska, which is the turnkey contractor. Midtbygda Sykehjem is a nursing home situated in Åsane, on the north side of Bergen. The existing nursing home is operating and has an area of approximately 10 000m². Today's building consists of three construction stages from 1972, 1982 and 1994, referred to as building 1, building two and building 3 (Resirqel, 2021).

The new building will be around 13 000 m² and it will be a short-term nursing home and rehabilitation centre with approximately 1100 rooms. In addition, the building will have a day centre. Midtbygda will have several connections to the Åsaheimen nursing home close by, among other things, by having a common head entrance, cantina, and waste facility (Skanska, 2021).

The new nursing home project is defined as a "green project" with a high climate and environmental ambitions. One of the focus ambitions is to reduce greenhouse gas emissions by 40% compared to the reference building. The project must be certified as BREEAM-NOR Excellent and is a pilot on an emission-free construction site. There are precise requirements for reducing greenhouse emissions related to energy and material use. This is the basis when mapping the potential for reuse. This scheme is updated every 3-5 years, and the new update was launched in April 2022, which means that Midtbygda follows the "old" scheme.

4.6.2 BREEAM

BREEAM is a British environmental certification for construction, and BREEAM-NOR is a version of it adapted to Norwegian conditions by Grønn Byggallianse. The BREEAM core value is called "The code", which is interpreted by two different standards, the first focusing on the technical, the second on process/operational requirements (BREGroup, u.d.). To approach minimising impacts on the global and local environment; maximising, among other things, the resource efficiency, health, comfort, safety, security of users, and socio-cultural

value (BREGroup, u.d.). “The main output from a certified BREEAM assessment is the rating. A certified rating reflects the performance achieved by a project and its stakeholders, measured against the standard and its benchmarks.” (BREGroup, u.d.). They also support a circular economy by adopting the concepts of a CE to rethink how resources are considered towards waste and materials. The rating goes from Acceptable to Pass, Good, Very Good, Excellent to Outstanding. To reach the ratings, the building has to get credits in a series of sustainability categories, ranging from energy to ecology. The following figure explains how to get the BREEAM rating:

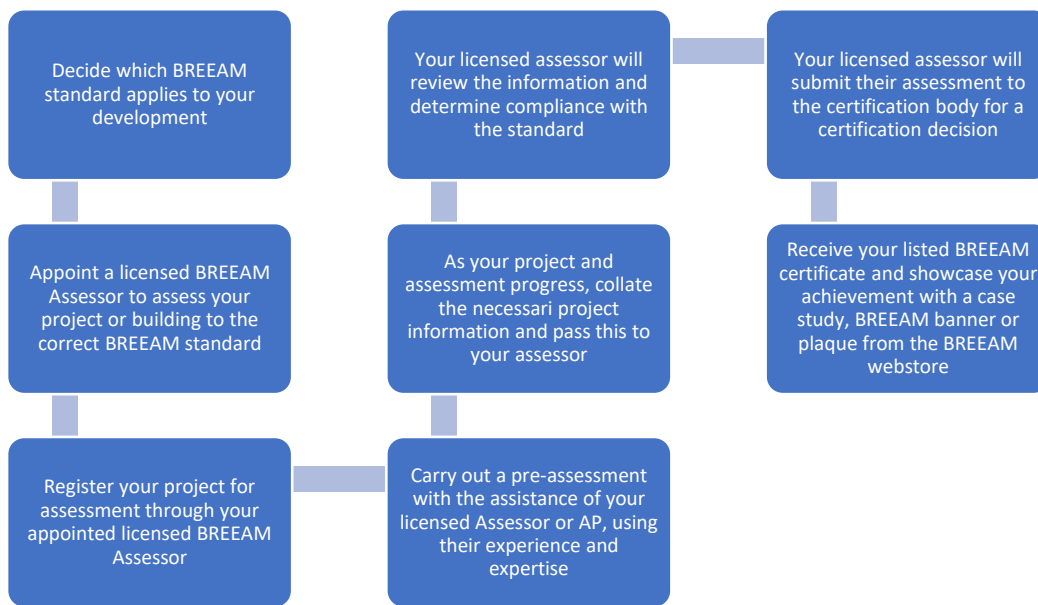


Figure 6 – How to get a BREEAM rating

Source: bream.com

An example of getting credits is, for instance, in the category of waste generated in a construction project. BREEAM divide this category into five sections. You can first get one credit with a *resource management plan* for reducing waste, another credit when you do a *feasibility study before demolition*, and two credits when the *quantities of waste* are measured. They are not too much; two more points when the *waste is sorted* (reuse) and the last credit for innovation when you are at an *exemplary level* with meagre amounts of waste (Bygg Alliansen, 2021). To get the credits, you also must reach a level of Very Good or Excellent, like in the following picture where they show the percentage of waste that must be sorted to get one or two points divided by what is sorted and what is ready for reuse.

Table 2 - Percentage of waste sorted for getting credits by BREEAM (Bygg Alliansen, 2021)

Poeng	Andel sortert	Andel klargjort for ombruk eller materialgjenvinning	Minstekrav:
Minstekrav Ingen poeng	75%	-	Pass
1	85%	50%	
2	90%	70%	Excellent

As I mentioned, this scheme is updated every 3-5 years, and the new update was launched in April 2022. In the latest version, there are new chapters about the ability to change and reusability, where the purpose is to facilitate future circularity in buildings by taking measures. This consists of three parts: a) material bank, b) ability to change and reusability (recommendations), and c) ability to change and reusability (implementation). They are still working on making the manual compatible with the rules of the EU taxonomy so that when achieving the level of "Excellent", they are linked with the taxonomy requirements for new construction.

4.6.3 River Club Project (RCP)

The River Club Project is a project designed by a client, while the contractors going to build it are WBHO. Being a contractor means that you have to follow the requirements set by the client. This project was operated by the proponent as a commercial facility, mainly recreational (golfing) activities and conferencing, and is strategically situated within the city. The site is bordered by the (former) natural channel of the Liesbeek River and Black River. The site, therefore, forms a virtual "island" surrounded by these freshwater systems.

The project is extensive, including critical elements like roads and parking, a massive building for commercial, retail and residential use occupying approximately 3.4 ha of the site, open space (11.5 ha) with an ecological corridor separating the two precincts to facilitate (and improve) faunal mobility, and rehabilitation of the Liesbeek Canal. Likewise, hard landscaping (4 ha) includes, among other things, covered pedestrian space, roads and recreation and leisure facilities. As well as stormwater and electrical infrastructure, waste management facilities including collection, sorting, temporary storage and collection areas, and sewerage (SRKConsulting, 2020).

In this project, the environmental management measures, rules and responsibilities are essential because of mainly the river and canal surrounding the area. Reaffirming that the standards that must be implemented are listed down. In that list, they have their section about waste management where they have to develop a waste management plan, describing:

- Expected type and amount of waste;
- Measures to reduce waste;
- Type and anticipated volume of recyclable waste;
- Recycling facilities that will collect/receive waste;
- Type of storage for different waste types; and
- Waste Contractors that will collect waste.

On the other hand, we find the Green Building Council and Green Star SA Tool. This means that the project is pursuing a 5-star Green Star SA rating for office development; this includes roles and responsibilities that have to be followed by the contractor to achieve this. This project got a 6-star rating in the design phase, while they are trying to also reach the 6-star rating in the building phase following the requirements set by the design company.

4.6.4 Green Building Council

The Green Star SA Rating Tool is a rating system that independently assesses the level of environmental design attributes of a building at the design stage and then again at the built stage. Some similar global tools are LEED in USA and BREEAM in UK and Europe. The instrument measures the "Greenness" of the building utilising a set of criteria and requirements divided into nine categories: management, indoor environmental quality, energy, transport, water, materials, land use and ecology, emissions, and innovation. For rating them divide them into credits, and the category score will be the calculated percentage of the points achieved and the total available points, where the best rating is a 6-star with more than 75 credits.

An example of these credits is when the contractor implements a Waste Management Plan (WMP) where a percentage (by mass) of the demolition and construction waste is reused or recycled as follows (SolidGreen, 2020):

- One point for 30% of waste;
- Two points for 50% of the waste; and
- Three points for 75% of the waste

In the WMP, we can also find a classification of every factor and a definition of what it means; in chapter 5.1.2 of their WMP, we find "Reuse" (WBHO, 2021), followed by the description "*Materials can be used for similar or different purposes without changing form or properties. Reusing materials from construction material to containers and excavated material shall be encouraged.*" (WBHO, 2021). One of the main ways they are managing the waste is clarified in the document a summary of how they are going to manage the waste in chapter 3.1 by saying, "*A dedicated team, including waste sorters, will manage the waste station by separating waste according to different waste streams/types of materials such as recyclables, general waste, hazardous waste, rubble, scrap metal, scrap timber and green waste.*» (WBHO, 2022). And the way they are going to reuse materials is by cleaning the builder's rubble (concrete debris, bricks, and cement) on-site to ensure that all contaminants are removed. Moreover, crush the rubble off-site and reuse it as fill material within the construction project. Additional to that, they are open to reusing the rubble off-site for different projects other than construction (WBHO, 2022).

5. Analysis and discussion of the cases

The project has one main research question "*What are the drivers and barriers of reusing materials in a construction project?*", then I divided this into two sub-questions, where the first is "*How is the learning process when implementing reuse of materials in a construction project?*" and the last one "*How will the supply chain be reorganised in a circular construction project?*". And this is how I am going to divide my analysis. I will start analysing drivers and barriers that I found for so going through the learning process and then the organization to see how some barriers can be overcome.

In this chapter, I will be using all my collected data from the theory chapter, the interviews and observations to analyse and discuss those three research questions. In my analysis, I will focus on the Midtbygda Sykehjem case, on which I have richer data material. However, I will compare with the River Club Project on relevant aspects towards the end of every chapter. I will be discussing the drivers and barriers (chapter 5.1), then the learning process (chapter 5.2) and the organisation (chapter 5.3), which together will lead up to a conclusion of how increased reuse of material building projects can be made possible.

5.1 Drivers and barriers

This chapter focuses on the question, "*What are the drivers and barriers to reusing material in the construction industry?*". As mentioned in the chapter about barriers and drivers, we can find those on two levels, at the system- and firm-level. I focused on the project Midtbygda, looking at barriers and drivers from different perspectives. While some were more affected by the authorities, others would come up with the economic part of making such a change in the processes of building.

The relevant theory for this chapter is everything written under chapter 2.3 about drivers and barriers that will affect the reuse of materials in a construction project. I will analyse and discuss all the different aspects mentioned during that chapter.

After going through every interview, reading theory, and observing the construction sites, I found several drivers for reusing materials in the construction industry. To connect this to the theory chapter, where it is divided into several sub-chapters, I will be explaining them the same way.

5.1.1 The drivers

One of my main questions in the project, and what I wanted to focus on, is why the industry and particularly some companies, want to change the processes and how they work and integrate the reuse of materials in their projects. What drivers make them take the first step and try it? Making changes in an industry can be driven by many factors; I mentioned some of them. The ones that I thought were most important for my project during chapter 2.3.3. and now I am going to analyse and discuss them.

When interviewing the informants, they used a term in common; everyone mentioned **motivation**. Meanwhile, there must be reasons to decide to change mechanisms that already work. I liked both definitions described during chapter 2.3.3.7 because the first says that there must be a reason for acting or behaving, and this can be used to explain why people in the industry would work against that goal. While the second is about the facts and arguments that are used in support of a proposal and also why the industry would change processes in support of a bid. Therefore, having this in mind, I divided motivation into two. The first I wanted to

call the **inner motivation**, which is more related to the first definition, and the second **industry or company's motivation**, related to the second.

On the other hand, I separated **profitability**, **authorities**, and **competition**. At the same time, all these factors can directly influence the motivation of a company or industry. So, if I had to describe it in a figure, it would look like this:

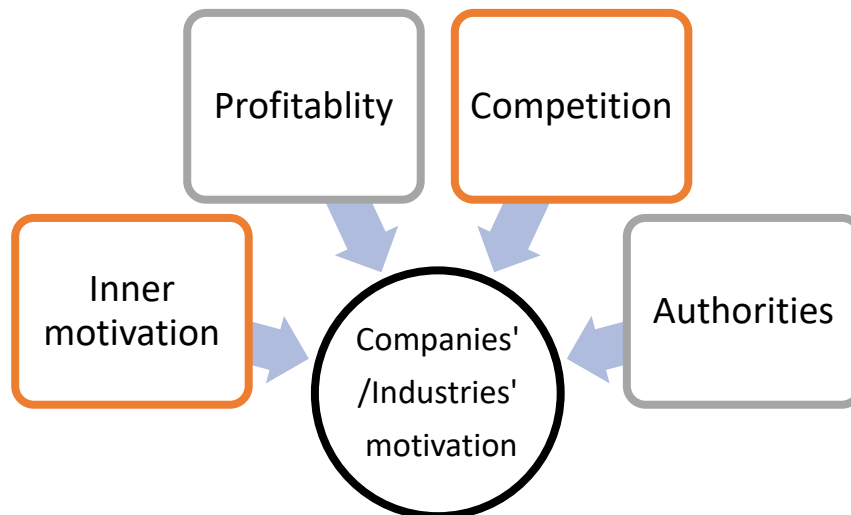


Figure 7 - Drivers for reusing materials in a construction project

I would like to explain how the authorities are a driver in this case, as Informant 1 said, *“The builder has set as a requirement to achieve the goal of 40% reduction of CO2 of greenhouse gas accounts set by the Paris Agreement. And even if it is not directly linked to reuse, it is probably dependent on using trade and reuses to achieve it.”* emphasizing that the builder is from the municipality of Bergen. And as Informant 5, who also works for the municipality of Bergen, indicated *“... the large emissions are associated with construction projects, so there is more focus on materials. If you are going to use new materials, there is a requirement for the greenhouse gas footprint per cubic meter of concrete or square meter with wood. And then is the desire to be able to use used materials then that will reduce the climate footprint much more.”*. As we can see, the municipality of Bergen sets some requirements for the new building, this engages the whole project and all the workers involved to reach those goals. What I found interesting is how the authorities setting new requirements make industries and companies think in a new way. How do the companies comprise environmental requirements and environmental goals as motivation. Informant 3 agreed that setting requirements for the projects and general for the construction industry might help. Still, the informant also mentions that *“... in some ways the requirements might be too much, the requirements will work for engaging, but when thinking about the recertifications where there are still no requirements...”*.

What we get from this sentence is that the informant agreed about the requirements, but those must be set according to what can be implemented in reality and not only in a perfect world. When the requirement is too difficult to achieve, fewer and fewer projects will be able to make it happen. As mentioned in chapter 2.3.3.6, such requirements from the outside world or regulatory conditions such as the Paris Proof can force the companies to innovate. Going back to what is mentioned in this chapter, there are several ways to set requirements and rules. The accounting rules, for example, affect the profitability of the innovation; this is an example of something the authorities could do to make all in the construction industry reuse. Informant 5 mentioned a good idea the municipality of Bergen came up with, for starting to move reusing materials possible, making more companies to change and start reusing materials even when we know there are some challenges "*... the materials that come to the storage location can be free at the start, and gradually set prices, so we get the movement of materials in the warehouse...*" And I think this is a perfect impulse for the industry. That is not something that is already in use, but this will be a great driver if they start like this. At the same time as the municipality of Bergen has thought of setting new conditions, such as reusing a percentage of materials in every project "*I think that probably the best way to do that will be to have it for free at the start. The municipality of Bergen will disassemble and map, put it into a database and give it to the design phase engineers. And then set requirements for how much they have to use from the database, and all the costs will be covered from the municipality of Bergen at the start*" (also mentioned by Informant 5). This is a great example of how the authorities, in this case, the municipality of Bergen, can use their power to make changes. At the same time, this can be directly related to requirement number two mentioned in the same chapter. The environmental requirement, reusing an amount or percentage of materials, is a requirement that will lead to reducing CO2. Just as the enabler (Jim Hart, 2019) also mentioned, the incentives such as reducing the VAT when possible. Everything is for getting to the goal of making reusing materials possible and affordable. Just as Informant 4 said, "*...the municipality of Bergen is an actor with political interest. So, we have the general guidelines as a requirement for the municipality to get greener. We are going to implement this in future projects. We are working on that; they have even hired an environmental advisor.*". Several informants mention the political, just as Informant 6 said, "*...also at a political level and international level ... it is in a way that, it should start as a superior level, and get the incentives to do that... when you look at the regulations you can see how it influences.*". As we can see, the political and the authorities can make many changes; in other words, the formal institutions have a big power. Another example mentioned by Informant 2 is the new taxonomies and new requirements that

are coming from the EU, also the new BREEAM manual. The authorities stimulate and encourage in this way. And just as this informant also referred to, "*... here are incentives. Everyone must get paid for the work they are doing, and someone must pay if it takes longer. It should be the builder, right? There must be a willingness in the builder to come out with the money, but I think the municipality of Bergen will hopefully do it. They will gradually sit with many buildings to get demolished, and they have to understand that they cannot just demolish everything; they need to take care of something and reuse it. So, they see that they need to increase their capabilities to solve this. The motivation is huge...*". Knowing that the public, in this case, is also a client, it is great to see how they also get motivated and spread it. This leads to the next driver, **profitability**.

Profitability is a factor everyone is looking to achieve; every company and every individual needs to see the results of their effort done. When the industry decides to do such a change in the processes that already work, normally there has to be more than one factor that motivates them. One of the most important for every company is money, what I call profitability in this case.

There are high costs when reusing materials, we will see that in the chapter about barriers. But what everyone agreed on in the interviews is that those costs are temporal; like Informant 4 mentioned, "*make the product work, and then the investments you made are closer to become profitable*". But the innovation doesn't happen in a day. Nobody can guarantee that this will be worth it in a couple of months or years. For instance, Informant 6 said during the interview, "*it is difficult to imagine the impact it will have on the business models of various.*" But there are no doubts that the industry sees a financial profit at the end of it, just like in chapter 2.3.3.4 where I described shortly what drives innovation—referring to the one-sentence where "*we can also find that the life cycle costing and new evaluation techniques incorporating environmental, social, and political sectors may increase the emphasis on the asset value of the materials*". This is the case where they involve all three; the environmental have we talked about, reducing the CO₂, our footprints and using less raw materials. But also, the social, this is a change for everyone, when buying new buildings, the new owner has in their head that everything has to be unique. But this is something that we are supposed to change in the following years with the circular economy methods. And the last one is political; we mentioned how the political and the authorities could influence as a driver.

Likewise, another way of seeing this is as Informant 6 mentions, "*... the benefits of this are that now is tough and time-consuming to find the materials, but you can get it cheaper than raw new material. If you think about it financially, it is some of the materials that are more expensive to reuse right now. But then you got other materials that maybe are easier to obtain and get from buildings and then making a profit in the financial accounts.*" It takes time, effort, and pilot projects to find out what is best to reuse, what is making a change and what is affordable to do. But there are no doubts that this is temporal, that the pilot projects help develop methods and processes to do it more accessible.

Shortly I would say that there are more costs than economical gain at the start of an innovation, but several times the authorities have the power and possibility to use their money on this. And after some time, the most of the innovations have the idea of gaining money from the change.

The following driver I wanted to discuss is **competition**; citing the chapter 2.3.3.2, competition can make businesses encourage and promote green images. Being the first company to challenge themselves can be demanding, but this will give the company unique competence and knowledge. At the same time as it will influence other companies.

The construction industry runs on the economy, which means that a considerable part of a project is knowing how much it will cost and how we can reduce the price. By reusing materials, the industry also sees the opportunity to make the costs of materials cheaper, so we can use more money in other situations. Informant 1 mentioned that "*... this is something everyone drives and competes about, the price, so we must impose some sanctions if you don't do as agreed*", where he also mentions sanctions, that's because if a company says that they are going to reuse materials and make it possible, and wins a project by saying that, then it has to be done, or sanctioned if not.

Another driver factor is common for everyone who makes changes, even on a normal every day. I am talking about the **inner motivation**, which many call "burning for something". As mentioned in chapter 2.3.3.7, personal driving forces and self-motivation are part of the most important reasons for creativity and innovation. When interviewing, I wanted to know if the motivation came from every individual or if it was something implemented by the company. And what I can say is that motivation is very personal; what motivates someone may not be the same as the person beside. Like Informant 1 said "*To be honest... It is gratifying to recycle. We get a recycling percentage of around 97% in projects, and those numbers motivate me. It is not necessarily that I'm burning for recycling*". What all of the informants showed to have

in common is that they recycle in their homes. While some of the informants were very into recycling, others also do it, but not at the same level. Motivation for doing it at a private state can be because of the fees like Informant 1 mentions, "... *it might be because of the fees that I get motivated. Had it not been for the fact that we had to pay interest on emptying, I would have emptied on residual waste*". Having personal goals is also a way to get motivated; like Informant 2 said, "... *is a bit like that we have some personal goals in this. This is how we humans are driven and forward with that we get involved in things. And then help drive professional areas forward.*". But at a private stage is another thing than recycling or reusing at work. Several things get them motivated to work on better recycling and reusing model in the industry. For example, Informant 5 comments that "...*it goes on the conscience of a project, to throw too much and increase the amount of waste. Right? So, we need to do something with what we already have...*" or as Informant 4 referred to "*it is interesting and exciting at the same time. It is so positive that the municipality and other actors want to work more with reuse*". Others can also get motivated or feel like working with something new like reuse because it is challenging; like Informant 4 said, "*at the same time I think it is nice ... it is very new and challenging. We have greater ambitions concerning reuse*". It doesn't matter if the motivation gets from seeing the amount of waste the construction industry generates, or if it is because others get motivated, so you find it interesting and exciting Motivation can come from everywhere. The last quotation will guide us to the next and previous driver "*The main motivation for reuse, if we think in a history timeline in Norway, it was because of the brevity of the materials, little material circulation made us start reusing. We had to use what we got and already had, so I think that might be our main motivation today. Trying to save the earth from the depletion of resources.*" said Informant 6.

The last driver I want to speak about is what I called the **companies and industries 'motivation'**—this involucrate all the drivers that I have already mentioned. There are several factors, areas and motivations that can make a company or industry change and innovate. We have seen how some external factors like the financial, salary, the competition, and the authorities can be driving forces; simultaneously, internal motivation can also be a driver. But the companies will also have their missions and goals; like Informant 1 said, "*Skanska have the goal of being a leading company in the construction industry on the green mindset*", and that is probably the primary motivation for making reusing possible for this company. Informant 1 kept saying, "... *they want to have a competitive advantage, they want to be at the forefront, and use this competitive advantage at the market. That is probably why they bet on it; they*

have their department working on it. Skanska also has many research and development projects working on different initiatives within the green transformation. I would say that Skanska is far ahead when it comes to green transformation." This is an example of motivation for the company, the advantage of being first out in the market, knowing how to do it, and competition. But also, the authorities have a huge responsibility for making the industry change and innovate, just as Informant 1 quoted, "*... even when Skanska aim to manage to be first out, ahead with knowledge and to have the right people, they are still dependent on the client who orders and must pay for those measures. There are many public buildings, Norwegian municipalities and ministers who run the process, which will automatically bring along other contractors. They will appear soon, I am sure. We are just out too early because we see that it makes sense. We are going to make money from being best.*" As we can see from this sentence is that there are still not many companies reusing materials, but they are sure that they will appear. The authorities in Norway are making this process and change possible, and they are doing a great job of incentivising the industry to do the change. But the industry is still dependent on the money from the authorities.

Normally, the first companies to innovate are the big companies, Informant 4, which works in the municipality of Bergen, mentioned that "*Skanska and Veidekke are the biggest companies who want to sell themselves as greener, that is something that the clients want to hear, especially the public ones. That is why they need to have pilot projects like this.*" that is something exciting, how the ambitious and big projects are so attractive for the companies. Those projects involve a lot of money, and they see the possibility of channeling many factors into one task instead of having many small projects. Innovating is challenging; reusing materials have many barriers that we will see in the next chapter, so being part of the movement is not something done in one night. Like Informant 6 from Resirqel said, "*... we experienced a positive change of attitude during the process, it is probably because they realise that there are more and more actors and companies who are going to demand reuse, so they understand that it is positive to get it early in in the routines.*" referring to other pilot projects where they have already tried reusing.

5.1.1.1 Drivers compared with the South African project

Now that we have seen the drivers related to the Norwegian project and the interviews there, I would like to compare some of them with the project of RCP in South Africa. When going

through the interviews, I found two drivers in common with the ones from Norway. The profitability and the motivation. While there are only two main factors, I would also say that they are directly connected with the rest mentioned in the last chapter. I will explain it through the quote by Informant 7 "*we want to show that we can deliver the type of product because the whole world's going, but the client is paying us for that. But the client is paying for a more proficient contract to achieve that, and that's the way I think we are different from other contractors in South Africa.*". In this quote, the informant is talking about the client as the one who comes with the money and who is willing to pay for the changes in the processes. The same as in the Norwegian case where the company see the future in the innovation implemented, but someone has to be capable of paying the costs at the start. At the same time, if we compare the last sentence where the informant says that they are different from other contractors with the Norwegian case where they want to be the first to achieve the goal of reusing. We can see the similarities in the driving force of wanting to be the first out; the competition is a driving force for innovation in both cases. And at the same time, it is what motivates both companies. Just as Informant 7 also mentioned, "*The world is going green; we in South Africa don't want to be left behind*" that's another way of seeing the external motivation and how the different countries and authorities can influence others without even noticing.

5.1.2 The barriers

Now that I have gone through all the incentives I found during this project; I also want to mention all the barriers and challenges that we have already seen or that may occur. Many factors can affect the way we see things; motivation is much more than what makes us happy; the culture, the competition, profitability, and almost any factor can motivate us to reach goals. I found it difficult to divide into sections because everything is related. When someone talks about the lack of motivation because of the private profitability, saying that they don't get paid any extra for doing the additional job, it is directly connected to the firm's culture, for example. Or how the authorities help the actors who sit with the new activities to get through the difficulties to reach the goals, many get motivated through money.

What I mainly found is that the biggest problem is the logistics. When talking about logistics, I can involve in many activities in a construction project. But from the interviews, I would say that all the barriers are interrelated. When talking about time, it is also related to the certifications or transport. Then the costs involve everything from the transport, to the market,

and then to the final client. All the barriers are connected, and if I had to describe it somehow it would look like this:

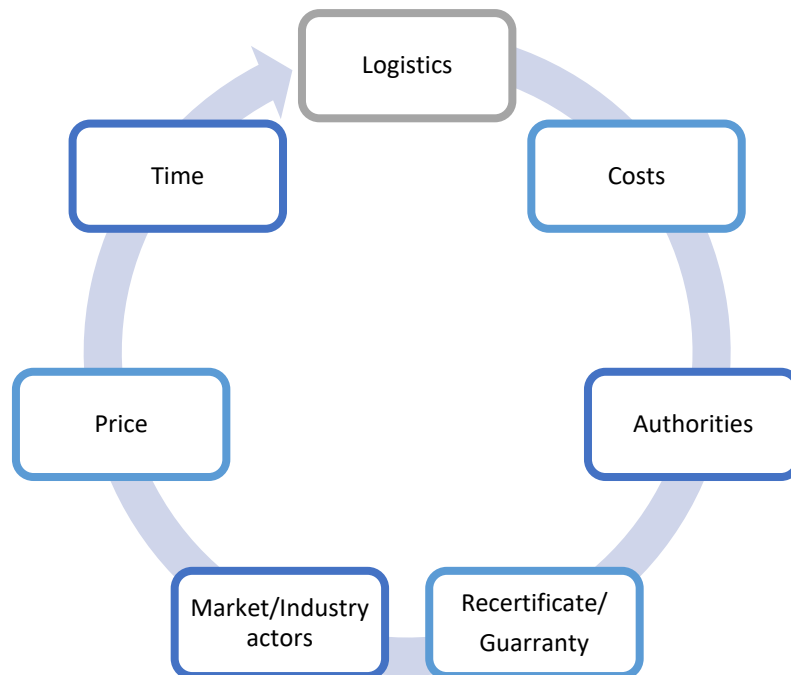


Figure 8 - Barriers to reusing materials in the construction industry

The informants gave me some insight into the current state of reuse in the construction industry, all of them agreed that reusing is something new but old at the same time. There was a time when we reused materials in the constructions, but now we are used to building with everything new. As informant 1 said, “... *the older generation knows how to reuse, they do it all the time, even in their homes. We just have to start doing it again...*”. So, reusing will be more of a going back to where we were, but with changes.

One major issue that we are facing is the **costs**. The costs go all the way in a construction project, but the problem I found in common from the interviews is that everyone was mentioning costs related to new processes. We want to reuse the perforated concrete covers from the old building into the new. There are some logistics to do; where to transport it, where to store, how to keep it, how and who will re-certificate it, and all these steps are extra costs. But other costs from standard projects will be taken over by these. Costs are a challenging part of the project, and all the informants agreed that it is because we are trying something new. Like informant 1 said, “*It is a balancing act, costs, and the intention of cutting the CO2, right? In the stage where we are now, there will be more costs in reusing anyway. Relatively high additional cost, so we just have to do that and find out if it is worth the money because we have to find that balance*”. It is part of innovating, having pilot projects. Someone must take the first

step, use money so we can work on making it better and get a profit out of it. The ambitions in a project can often be the pump starting the innovation, but the money can stop the purposes; like Informant 4 said, *"Ambitions are very high, and I think that often in the start of the projects the ambitions are super high, and when the time starts running, we initiate to understand how high the costs are, but I don't think this will happen in Midtbygda."*

The costs are one of the most outstanding issues mentioned during the interviews, as Informant 1 also said, *"... but let's say this project costs 50 million to implement all the environmental ambitions in this project. So then, they take the 50 million and think "what else could we have done with this amount of money?" thinking that they could have done a lot of good for that money. It is not enough being climate change related to starting questioning if it is correct to use the money this way. But we need to spend that money to make it happen."* This already leads us to the next barrier, the **authorities**. The authorities have the power to encourage not only one but several companies to make the change. When in a project is expected that more than one company works on the construction, for example, the subcontractors. We also saw in chapter 2.2 how a management supply chain involves many actors, like distribution, production, strategic procurement management and industrial organisation economics. But when the authority decides to encourage them, it is essential to think of every level that such a change will touch—understanding that there is a network of organisations involved through upstream and downstream linkages.

When talking about the authorities, I refer to everything involved to that, the states, and the institutions. Who comes up with rules and requirements? Who can change them? Where comes the regulatory conditions from, forcing companies to change and innovate? The authorities in Norway are very interested in sorting the waste; as Informant 1 mentions, *"... the challenge in Norway comes from the amount of waste sorted. You can have as much waste as you want, as long it is sorted."* And that is not how we should be thinking right now. To make the change in the circularity in the construction industry, we need several steps to get more straightforward and understandable. In chapter 4.3, I explained how to reduce waste and the principal stages for reducing CO₂. Having a crazy amount of waste, even when it is sorted, doesn't help the same as lowering that amount or reusing some of it. Having a political party that accepts and encourages investing money for pilot projects where we can try to start becoming circular is crucial, *"political engagement that is against using so much money because they think it is too expensive ... makes everything even more challenging"* as Informant 1 mentions. Informant 3 thinks that *"... public clients should be the one to push for innovation, but I don't think they do*

enough. They get often stopped by the economic part, and then the responsibility." And it is not only the money stopping from the authorities but also the flexibility at certifications, finding new ways, motivation to make it possible, etc. When the authority just sets up a goal that everyone has to reach, but with old ways to make it possible, there will be more challenges in the way than the authorities can anticipate. Like Informant 5 says, "... how to storage and how to sell. The documentation of sales regulations..." or "... there are some challenges concerning the certification of materials that have been in a construction and taken for a further construction" as Informant 4 said, are just some examples of challenges that can come up, how the formal institutions can make it challenging. Informant 2 recognised that "...things are happening, things are changing, but I would not say that the authorities are with us. They are not the driving force they should be, but we get something from the EU, fighting inwards in Norway via taxonomy. They are coming with requirements, but it's normally not from the authorities in Norway". Informant 6, who also had experience from other projects where they have already reused materials, mentioned, "...we have the regulatory or regulations, call it barriers or challenges, and I experienced that there are many who are a little intimidated by it. It is also complex and difficult in relation to guarantees and responsibilities. So, we must work with a focus on this and get it in place with all standards that can describe the best practice." The authorities are the ones who can change this barrier by being more flexible with the certifications or finding who can be responsible for this.

Those examples point to the next barrier, which I wanted to call **recertification** and **guarantee**, because when doing something new, there are some disadvantages. Today the market is accessible and has been the same for a long time. We buy new products and materials, and since they come from certified production places, with the machines, products and even colours they must be, they come with a guarantee certificate. When the product you bought has some imperfections is easy to go back to the producer, explain and fix a problem. But when reusing, there will be many hands touching the product. One big problem we are facing when trying to implement reusing in construction projects is who is going to sit with the responsibility of every product and material? If something gets broken or damaged in the project, before and even after the building is finished. Who can ensure and guarantee that the material and product will hold?

After the interviews and going through them, I found another common factor that I didn't think about before—the **market and industry actors**. Most of the literature is about how the market is a driver and how the changes might start from a market (Birgit Abelsen, 2013). But what

happens when you innovate without having a market and the needed actors? Then you have to make the market. This is happening with this project, and where they are trying to reuse materials. As Informant 2 said, “... *this is an obstacle race all the way, we have a lack of players. We don't have enough marketplaces for the whole thing.*”. The question is, who is going to be the first ones to buy used construction materials? There might appear new challenges like Informant 6 says, the colours or the size can be different than wanted “*you see, for example in someone who wants to reuse, let's say it is a door or an office desk, and then it may not be quite a colour they want. There are ways to re-laminate or do small things with it. Then we need the actors, competent people who can do such things.*” “...*we are in a transition phase. It is difficult to say when we will become experts in this, but I think that when more and more people are reusing, and we get to develop the market, there will appear new initiatives in place, just as Resirqel.*”.

Here the informant is talking about the market as the market of actors, the lack of actors since the methods are new. This also is directly connected to the final buyers of the materials. Just as this informant said, we need new initiatives, new actors who take these operations. Informant 1 mentioned how they bring in consulting engineers “*In the project's design phase, it is normal to bring in consulting engineers from a specific area. It could be for the logistics or fire and all these professions. But when it comes to new professional roles and new issues, there is no established market with consulting expertise and experience.*”. This can be a disadvantage of being the first to experiment in this area.

The municipality of Bergen has already initiated a project where they reuse furniture. They have a storage place and warehouse where they also repair the table and then reuse it. When talking with them, they mentioned that the only client now is themselves, it is probably because it is easier to keep the furniture in a loop within the same organisation... the advantages are easy to see, you can skip the paperwork of selling the table, but the disadvantage is that more people could be buying the furniture and get the market to get bigger. But all this is a learning process, step by step, just as Informant 1 said, “*We haven't done this too many times, just a limited counted times, and that's why we have to get out and try new things, but it means that we have to try and fail, which again takes time*”.

This last sentence from informant 1 gives us the two following barriers, **time** and **price**. I separated price from costs because there are many factors under expenses, as I mentioned further up in this chapter. But with the price, I mean, among other things, the new cost of the

materials. As I said in chapter 2.3.3.3, today is cheap to buy new and raw materials, and innovation often leads to an upfront investment at the start of the process. When a firm plans on building something, they have to list all the costs. The money is limited; every project will have its limits depending on the location, the area to be built, the ground, the size of the new building, etc. But everything that can reduce the final costs will often be welcome. And if the raw material, which is the number 1 competitor of reused material, is so cheap, it will get challenging to sell the used one. That is why the price of the used materials needs to be set according to many things, but at the end it has to be accessible for the companies who will use it too. As Informant 5 said, "*We think it makes sense that there is a price for those materials, so there must be a real need. It should not be more expensive than new, just as with the furniture project where the price is two-thirds of the price if it was new. It is still too expensive, so if we can make it lower, it would be great.*". Having references from projects, even when they are not the same, helps to know how to react to actual challenges that might appear. There are many ways to get to a reasonable price, as many new products does. For example, selling it cheaper at the start, just to get the kick into the market, and then normalise the price, or having it for free as Informant 5 has already mentioned.

But as we can see, everything takes **time**, which is the next barrier I found. Everything hangs together. The methods for reusing material are new; the industry doesn't have all the answers yet. The steps that will be taken are still insecure, and many actions may lead to different endings. What I am trying to say is that since this is something we have just done a couple of times, it is expected that it will take longer than in a regular construction project. All the actors needed to make it possible are yet not in place, like, for example, the recertification we talked about. Where and who is going to be responsible? This is time spent in something that the industry is not used to yet. The same with, for example, before demolishing, just mapping all the materials that can probably be reused without being fully secure that they will fit. Everything takes extra planification, which leads to using more time. Just as Informant 1 said, "*What is going to happen in the construction phase is quite accessible if we make a good plan. So I think the key is in the planification; it requires more planning in the early stages.*" or as Informant 6 said, "*reuse will require more material planification, material collection and more processes if we compare with normal processes*". This could also be understood as resistance for change, which can be a big barrier. But as I mentioned in chapter 2.3.3.8, innovation in this sector, where the industry is conservative, often demands changing the steps and taking more time to get to the results. The problem here is that time relates to costs when the processes take

longer means more use of expenses in working hours. And this industry works with deadlines, they have to deliver a finished building in time.

On the other hand, we can also experience some demanding processes in the building phase; an example is that there might be some elements or materials that are planned to be reused that end up getting broken or just don't fit the new building as they thought. Like Informant 4 referred to in the interview, "*...this can be a challenge. We need to have a plan B, and then we have to afford that it can be a new delivery time...*" already fronting that this can happen. The industry knows what works and how it works, so having a plan B is not normal when thinking about the materials. Just as Informant 2 mentioned, "*... we have to adapt the building so that it can also be used, the performed covers are long, as I understood they are appropriate.*" Because reusing will require thinking the other way around, instead of how the building will look and then finding the appropriate materials, they will take the materials first and then design the building, thinking about where the materials will be placed. This means more planning, more time, and more costs.

The last barrier, or the first, is **logistics**. This is something all my informants mentioned. Logistics for me includes all the factors I have already mentioned, but also the connection between them and more. The dictionary defines logistics as the detailed organisation and implementation of a complex operation. Logistics goes from the design phase, the mapping of the materials, the demolition, the transport and storage, and the building phase until the construction is finished. It can also be seen as the cognitive institution, in which the organisation and implementation of processes is part of it. And it is not only the planification of it, but also the physical has to be on place, like for example, all the materials ordered have to come to the place on time. Informant 1 "*performed cover are huge in volume and heavy, if we have to transport them it is going to be expensive*". Logistics can be planned, and if the logistics don't work as planned, it will be time using, followed by economic consumption. "*...it is part of a new experience. Damages can appear, and I think the logistics will be the biggest issue. A lot can happen suddenly, that can occur during the way which we are unable to predict.*" Said Informant 1.

Informant 5 agreed about the time-consuming, saying that "*it will be more logistics and more time-consuming to work with this... just disassembling the building, and then probably packaging this out of the construction site. It must be stacked away, so it doesn't get damaged at the site or while transported. In addition to the documentation, all the materials must get*

checked..." and Informant 6 "... we have to take care of the materials, when we disassemble and handle the materials, that one does it appropriately, and at one think through the processes, so the materials don't get damaged...". As we can see, many factors will affect the logistics, aspects directly related to how they will manage to make the reusing of the materials possible. Logistics goes from the moment they decide to reuse and build something until the key is delivered to de client. Logistics is all from transport, costs, storage, market/new actors, procedures and much more. There are several barriers and drivers, as we have seen this far.

Further in the study, I wanted to look at the learning process and the organisation in this change process. This is for understanding where those barriers come from and how we can overcome them. I will be looking at and discussing in the following chapters, but first, some barriers from South Africa.

5.1.2.1 Barriers compared with the South African case

Now that I have gone through the results and discussion from the Norwegian interviews related to the theory, I would like to mention what I also got from the project in South Africa, CRP. Since they are not reusing materials but recycling, I would say that the challenges might be the same. The costs and prices make it challenging to take a hand on it and make any change. When the raw material price is low, competing isn't easy. While they also mentioned that they started recycling and being more careful about that for not so long so that they might be focusing differently than in Norway. As Informant 8 noted, "*Building and the recycling is new to us. But it's something that we've managed to achieve since 2009. And we've streamlined the tracking schedules for the webserver. So that's enough systems now. And we've managed to fine-tune that, and we can do more green buildings.*"

During the interviews, I learned about cooperation, which was very interesting for this case, where WBHO cooperated with Ross-Demolition. What Ross-Demolition does, in addition to demolishing old buildings that might be on the site where they want to build, is to separate everything that the next owner or their shop wants to keep. They have a secondhand store where they sell, among other things, windows, doors, and furniture from old buildings.

Thus, the authorities are currently focusing on recycling. Organised material reuse would be the next step. There are presently few state-led incentives for material reuse. However, material reuse is expected in the informal building sector, providing a market (although with its problems) for materials from demolished buildings. This is a massive difference from what we

have now in Norway, where many of the incentives come directly from the authorities and are almost at a requirement level. This could also be a barrier for South Africa. I would love to have a globalised world where we help each other get better. That leads us to my next chapter, about the learning process.

5.2 The learning processes

The main reason for choosing to look at the learning process and the organisation at this innovation is to understand better how we can overcome the barriers and, at the same time, how the industry is connected. Today we use pilot projects to learn; we can't take the learning for granted. That is why I found it interesting to look at the learning process. On the other hand, I will be looking at those learning processes to examine how to overcome barriers. This could be the time barrier; during a pilot project, not having the consultants needed becomes a barrier, and how to react to that adequately can make them overcome this easily. Then they have learned to the next project, save time, and save money.

There is also a learning process in **cooperating** with others. It could be with other countries, states, municipalities, cross-industries or with other companies. As mentioned in chapter 2.3.3.7, competition can be a driver because it pushes companies to try to be the best, best at reuse. What I also found out is that there is a lack of cooperation in this project, and in general, in the industry, most the construction companies like working within the company. Even the municipalities lack formalised knowledge exchange on material reuse. Most of the cooperation in this area is one by employees cooperating on their initiative. I talked to Informant 5 about that to hear the informant's point of view, and that is what I got "*There is a huge potential for improvement if I say it cautiously. I have tried to talk about that with the municipalities because that is so silly that we have to sit on each of our toes and work on it right away. For my part, I think it loosened up a lot; I have my contact persons with similar roles in Trondheim, Oslo and Asker. I get answers relatively quickly. They help me, and then I can help back. But it should be arranged a way to fix it, so it was not only between big cities but that all municipalities could have insight into what they shared. That would be gold.*" This informant mentions a perfect point to improve that would help all the communities in Norway. While the lack of collaboration is not directly a barrier, more collaboration would speed up the learning process and, in this sense, contribute to breaking down barriers. If every worker has to make contacts and ask questions that probably many others have asked before takes more time than if we had,

for example, a joint database with this kind of information. Like mentioned in chapter 2.2 “*What a circular supply chain can do is go further and add value to waste by collaborating with other organisations. The collaborations could be in the same industrial sector or with other sectors (cross-sector)*” (Muhammad Farooque a, 2019). I liked that after the reuse report was ready, a workshop was organised where everyone was involved, from workers and managers to contractors, could share thoughts and experiences. Several things were discussed, starting from what they thought about reuse to what they could think of reusing, how, if there were other ways of reusing it than the customarily used ones, etc.—and having this kind of open-minded thinking brainstorming help innovating and during the learning process. Talking with the informants about that, there were some of them very optimistic about this workshop; others thought this wasn't so useful. Informant 2 way of thinking is “... *it was such a brainstorming, right? And then, all the groups come with written summaries of their discussions. Then it is taken in with the project management ... and then they can start to prioritise between the measures they have highlighted...*” it seems like an excellent way to get started on measurements, have new ideas and get the point of view from everyone involved in the project. This contributed both to project-wide learning and to find better solutions.

Learning from pilot projects is only valuable when it is transferred to other projects. However, **knowledge transfer** on material reuse has been unsystematic. For instance, informant 5 said, “*It happens fast that the project manager sits with that knowledge, even the contractor who has it in his fingers. But that knowledge from the project manager and further to other projects and managers is something we should be working on. It is not automatic yet that the knowledge goes further.*”. As illustrated by the above quote, Skanska has currently organised knowledge transfer between reuse projects. I learned from the Midtbygda project that the way they transfer the knowledge from projects to projects is by the persons involved in the project. The environmental consultant in this project is the same as the one in Kristian August gate 13. Like this person, many are in the project for a limited time to transmit the knowledge they got from the last project, so they don't make the same errors. It is a great way to do that, but I think there might be better options. One person cannot be at the whole project simultaneously; it is easy to oversee something happening, or that has happened. This is part of the learning process and something they need to work on. Having a person responsible for bringing the knowledge from a project stored in one person and not in the organisation or company is vulnerable.

We have seen in the past chapters how the authorities have the power to incentivise change in industries and companies, but at the same time how they can immediately or unconsciously be

a barrier to making those innovations possible. Based on the theory (Scott, 2013), the authorities would be the regulative pillar in which they come with new regulations such as the Paris Proof Agreement. That's one of the most significant incentives that made the world change and be more conscious of what is happening. This kind of incentive helps find a way to innovate, and in these cases trying through pilot projects is a way of innovating. Having pilot projects makes it possible to see where the challenges will occur and then be ready and react when it happens again. They will be able to manage all the methods, get experience and create flow in the processes, so most of the barriers that I mentioned in the last chapter will disappear. Just as Informant 4 said, *"So far, we have only had a few pilot projects like "Regjeringskvartalet/Storbylegevakten" or "Kristian August gate 13" on a smaller scale. The costs are still high, but this helps deal with this and with the materials."*

Another example of a **pilot project** in Bergen is the one Informant 5 mentioned: *"The town hall in Bergen is an example of a reused building where we chose to keep the building instead of building a new one. We saved 70% of the greenhouse gas compared to a new building"*. When having pilot projects, we can also find out about almost impossible amounts to count without doing so, just like waste or greenhouse gas emissions. Even with small pilot projects, like Informant 4 said, *"... when you read about Regjeringskvartalet in the news, it sounds like a huge project, for example, when they talk about the perforated concrete covers, right? ... I don't remember the numbers, but it wasn't so big. But it is clear, it is a learning process."* All the **experience** they can get, even from small projects, is welcome in an early stage. Just as Informant 4 mentioned, *"It is fun to be part of such a project, hope that we get good experiences and so on, and we will possibly be better to the next project."*, step by step, having failures, but learning from them; it is part of the learning process. This is the learning process at the company since they will learn from their failures. But we can also see the learning at a system level, in which the authorities can learn from the pilot projects. The local authorities, such as the municipality, will learn by being part of the project. Else, the learning process for the state is not directly connected with every project. Therefore, we find some incentives from them, but other state regulations make this innovation difficult. I find it essential to keep having pilot projects in which the barriers that appear the authorities can solve are taken further to the municipality or state.

But I agreed with Informant 2 *"I think we are well on our way, and I think the Norwegian construction industry has come a long way without any definitive answers for how to do reuse."* This also leads to my next and last chapter, about the organisation of the project and how they

can overcome the barriers. But before I go further in the discussion, I want to mention what I found from the task of RCP.

5.2.1 The learning process at RCP

The steps taken in this project have been different than in Midtbygda Sykehjem. First, they don't have the same barriers. But the challenges they have been working on in the past years are related to recycling. They still think this is very new, and they are working on doing it in the best possible way. Like Informant 7 mentioned, "*... the recycling is new to us. But it is something we have managed to achieve since 2009. And we have streamlined the tracking schedules for the webserver. So that's enough systems now. And we have managed to fine-tune that, and we can do more green buildings.*" Out of this quote, we can understand that they are proud of how far they have gotten, even when they know that they are not where they want to be. They have managed to overcome barriers, and through projects, they have become better and learned a lot. They also showed me a picture of a big project in 2008, where everything was a mess. Like Informant 7 said during the meeting, "*That was a proper mess. Now we have dedicated light down, it is still messy, but it is contained.*". And out of the observation I did on the construction site, they have come a long way.

Everything was really in place; it also looked like the health, safety and environment that we are so concerned about in Norway are also in place in RCP. What I think was most interesting to look at in this project is the cooperation they have with Ross Demolition about the reuse of materials and furniture from buildings. This is an excellent example of the collaboration I was talking about. Shortly, what Ross Demolition does when they are appointed as the demolition contractors is to spend the first weeks on the site stripping out all recoverable and reusable materials, like windows, doors, cupboards, pavers, roof trusses, wood, etc. The items get transported to the different stores for resale; in the house, they have carpenters who move between the branches and renovate valuable items. And then other materials get sorted, like the steel, which gets weighed, and they get paid back from the dealers, the bricks get transported to store yards, cleaned and resold; and the concrete transported to the crushers to be crushed and sold as subbase. I got told from a worker at Ross Demolition on an e-mail that their golden rule is that nothing gets ever sold from the site and that the managers can also purchase from the public who may wish to sell items of any worth in the market.

It is interesting how they managed to find ways to reuse more minor and not so tiny things compared to Norway. Informant 8 told me that *"the main people who buy from this salvage store or secondhand store are architects searching for a rustic look or people with fewer resources."* That might be the barrier in Norway since we don't have this market. In Norway, cognitive institutions expect that everything in the building is brand new; as Informant 4 mentioned, *"...when the building is delivered to the client, they expect to have guarantees, and everything should be new"*. That is something we should work on. There are two ways or mechanisms to be followed; the first is by being more environmental conscient, changing the normative institutions, hence changing the expectations. And the second, more practical, by changing the expectations. Also, If reuse becomes more common, for example, if the public focus on this, will clients change their minds and get used to it.

Another thing they are getting better at is going from paper to digitalisation. As Informant 7 mentioned, *"We are moving away from paper innovation as an outcome, at the most of the systems are small systems apps, they are similar in production. That is how we recycle."* That is also something I reacted about when I got to the barracks at the construction site, and they were going to show me some things. They had many folders full of papers. I can imagine they were requirements and much more. While in the project in Norway, I got access to the main SharePoint on the internet. I am sure that they have much of it online, but they still work a lot with physical paper. Finding apps and sharing programs that work for everyone and then incorporating them is not something done in a night.

Shortly I would say that they have come a long way, but in different directions than Norway. While Midtbygda focuses on reusing, RCP focuses on recycling, getting everything in place, using less paper and more apps, and reselling materials and furniture from buildings.

5.3 The organisation

I am jumping into the last discussion chapter of this project. I am going to discuss the organisation of innovations, having the background from chapter 2.2 about production networks and the interviews and observations again. I will discuss how reusing materials influences the supply chain and, therefore, the organisation of the construction process. Making changes in the supply chain complicates the process. Thus, mapping out the differences between a "classical" supply chain and a circular supply chain in construction draws forth several key barriers to reusing materials, but also possible organisational approaches to

overcoming them. And again, in the end, I will compare the project from South Africa, the RCP, with what I found in the Norwegian project.

As mentioned in chapter 2.2, the supply chain is the network of organisations involved through upstream and downstream linkages in the different processes and activities. This will affect all workers, contractors, suppliers, etc. When innovating, these upstream and downstream linkages may change, that is, for example, because new actors will take place, while others may disappear. I will be looking at that, understanding the logistics they talked about during the interviews, and which new actors are taking place or that should appear soon.

The background of how normally a supply chain looks like in a regular construction company, like the model presented during chapter 2.2 where they divided the supply organisation and the demand organisation. Commonly, the chain gets altered by, for example, contractors, clients and consultants. That is what I was most interested in looking at, what are the new collaborations that have appeared so long and that will appear. Having this in mind, I got some of the informants to describe how have been the process so long, what was done and what was coming. Informant 1 told me that "*when the competition came out, it was a tender competition from the municipality of Bergen. We then had to submit tenders for the project, including prices. But what was most important in this case was our understanding of the tasks. How Skanska wanted to solve the tasks by, among other things, describing these climate and environmental ambitions for the project*" even when the price is essential, I can see that in this kind of project they emphasise with other things like the climate ambitions in this case.

Informant 1 keeps telling me how they started finding first an actor who could help them make an offer. That's where they got the contractor Resirqel which helps them map materials. "*We know from experiences in other projects that they know how to map the materials. They also can create a methodology for reuse which we can benefit from in the project.*" Informant 1 said. That's the first actor that generally is not part of the supply chain in other construction projects. The next step, when they won the project, was to find out how to solve different tasks, one of the managers from Skanska came up with the idea of having a workshop where several things were discussed. The workshop was open to any ideas, so everyone got a chance to contribute something.

Informant 2 agreed, "*...you get to lift all sorts of issues, and how we can solve them. As brainstorming is super*". At the same time, they were working together with the clients. As Informant 4 described, "*The first we thought about was mapping the potential materials for*

reuse... then we needed to have our licenses for digital databases where we could collect all the materials together. Until now, there have been advisors who have used their databases. It has been Resirqel and Loopfront." Loopfront is another advisory company where that help with the reuse. At the same time, they have focused on reducing the greenhouse gas emissions by 40% and the BREEAM scores. Hence, they get the "Excellent" certificate. The next step is finding out about the logistics, like if it will be necessary with a warehouse to store the materials, in that case, where should it be placed, how about the transportation, the costs, if there are damages that can be fixed and the recertification of the materials. There is a lot to plan. Just like Informant 4 mentioned, "...there can be some materials that can be taken out and store right in the site. Or some of it will be products and materials that need to be taken to another place for storage before they take it into the new building." But as the informant quotes at the end of this, there has to be motivation from the whole supply chain about reaching the goal of reusing for making it possible "... it doesn't help if it is only the client and Skanska who desires the same. It has to be the whole organisation, all the way to the trade handling this together."

Further, we can say that they had Resirqel in the building for an observation to map all the materials. They got a mapping report with everything they found, but they recommend doing a second inspection to get more details since the first report is very general. As Informant 1 told me, trying to define what they have done so far shortly, "*Resirqel did the reuse-mapping. They took the first step in the building for mapping which building parts may be suitable for reuse. And we also got an environmental remediation report, where they describe environmental taxes, so they can be quality assured. The stuff that can't be reused must be set apart, out of the circuit and treated specifically. Those two reports were also discussed in the workshop. Based on it, we have made a list of the most important reuse areas we will work hard and focus on.*" Hence, now they are just planning how they are going to do it, how is it going to work and the steps. Informant 6 also told me how they managed to do the first mapping telling me that "*We go inside the building, take photos, and note all the product brands and marks that we observe. Then we ask for several papers, certifications, and all kinds of information that we can get. And when we do the inspection, we like going with the operations manager. They will always have a unique knowledge of the building and updates made.*" They get information from all possible ways to do the best mapping possible. This is a company with new knowledge, doing something new that few companies have thought about and going into the construction industry's supply chain differently. But when they come to the construction

phase, it will be another thing. Like Informant 1 kept telling me, "*What will happen during the building phase will be fine if we plan it great. The key is in making a good plan, which takes longer time during the planning phase.*" And then comes the first big difference from a classic project.

As Informant 1 told me, "*Under the planification phase of the project, we are used to bringing in consulting engineers from different disciplines. Consulting engineers for the logistics, then the fire and all these disciplines. When there are new professional roles and new issues, then there is no established market with advisers that have competence and experience. Here, the challenge is to find the right people with knowledge so we can use these people to solve problems.*" He perfectly described one primary challenge to re-organise the whole project and processes. When implementing new methods, such as reusing materials in this case, it will affect many areas where the company will have to be ready to think differently and do processes in other ways than the common ones. In this case, he told me about expertise areas, where commonly, the company would bring in consulting engineers from these areas to do their job. Since reusing materials is new, there are no consulting engineers with experience working in this area, which leads to having a grey zone and needing to organise this with what they can find. This is also represented in figure 2 from chapter 2.2 compared to the one I made at the end of this chapter. One of the main changes in the supply chain, and therefore in the organisation, is in the box of consultants.

When innovating, you must be ready to change minds. As Informant 6 talked about during the interview, "*... the first difference from normal projects is that you are in an overactive process all the time. You can say that you must always adapt to what is happening. You cannot always decide first. As an architect, I am used to drawing a solution and ordering off-the-shelf items from a warehouse. While in this case, the market is developed in a way where there is no warehouse, then we have to decide out of the materials we got.*" This changes the order of the different acts in a project. As this informant told us, instead of drawing, making a list of the materials they need and then ordering them, they need to think the other way around. Firstly, which materials are available, make a list of them and then "where can we put them? How can the building look if we have these materials?". Then, further, in the mapping of materials, they will put together all information they got into a report for planning how they pretend to reuse the materials. Informant 6 kept telling me that in that phase, they need to agree on what and how they want to reuse. The client has to be part of it, and then the good idea is to do a second mapping where they go into details. Just as Informant 1 confirmed, "*You can't just get into a*

finished drawn building and then put in something to be reused, then there will probably be a lot that doesn't fit." There are no doubts that this changes the way they work in many aspects like Informant 3 said, "*... for getting greener, that's when we touch through many areas. It is the same when working on energy...*".

Moving on to the next step is defining the so-called logistics. Here will, the supply chain changes a lot. The logistics are a composition of several factors, such as transport, certification and storage. I mentioned those three because it is something all the informants said, transport is a big question since they don't know if they want to have a warehouse and store the materials there, or if the materials can stay in the construction site until they get reused. In those cases, do they need to package them so they don't get damaged? Those are questions that need to be answered during the logistics planification. Then, on the other hand, they have the certification, which many informants called for re-certification since the materials will be reused. Who will do it? Who is going to be responsible for the certification? And the storage, as mentioned before, do they need it? Where is it going to be? Who will be accountable? How big? Etc. Like Informant 6 said, "*We need to plan the implementation of recertification ... How should it be handled on the construction site? We need to be clear about what to use so that it is not damaged in the process. And then it has to be dismantled, then sorted. And so, it must be sent away. It is all about the re-certification process, documentation, process and how to solve problems around it and so on ...*". There are many steps and acts that will be different from a "classic" project, and they need clarification.

Talking further about acts, the actors involved are also going to change. They are used to bringing in consultant engineers to do some of the work since they have the capacity and knowledge to do that. One of the new actors is Resirqel; they are doing the mapping and have some experience with small and more significant projects. They are also the ones who did the mapping at the Kristian August Gate 13 project in Oslo, and therefore they can help with knowledge. Informant 1 also mentioned that Resirqel has a reuse station in Oslo. Still, they are only consultants in Bergen, which may help us to install a reuse station in Bergen since they have already gone through the learning process and got the knowledge to know how to make it possible. There are also two other companies I haven't mentioned yet, Vill-Arkitektur. Informant 1 said that "*Vill-Arkitektur wants to start a reuse station, in consultation with other actors, it is an initiative, but there is nothing established and started yet.*". And the second is Loopfront, which is similar to Resirqel, but Resirqel has not yet a platform for the materials. As Informant 5 mentioned, "*Loopfront is good at making new market spaces where you can*

present what you want to, and then you can order the materials you want to use in your project. It is effortless to use to book and buy materials." Those are two examples of consultants and actors taking place in the supply chain of the construction project that usually wouldn't be part of the process. But as Informant 2 mentioned, *"It is challenging, right? We need new actors; there is a lack of marketplaces..."*.

The next thing I got surprised about was how much the industry works on trusting each other. Several things can happen and are difficult to demonstrate, or that would take much time to prove, so they rely on each other. I don't know how it is in other countries, but an example of what I am telling here is that I was asking the informants what challenges they could see coming. One of the questions was related to the construction phase since they haven't started to demolish yet. And many informants answered that if there appear to be difficulties during the construction and there are contractors who must deal with that and fix it differently than what they thought, they are open to that. So, I started wondering how many of the workers in the construction will work upon the goal of reusing and how many will be too lazy to implement new methods. Then I got answers like, *"There is a lot based on trust; this is nothing new. But I think that it is important that we who build should help contractors in the right direction and that we don't just set it as a requirement, and then we will go out and check afterwards. In a way, we have to make each other good."* this is by Informant 5. But trusting each other is something they have done for years; it shouldn't be a problem. A project manager can't check that all is done as it is agreed and required. Like Informant 2 mentioned, *"I think it is very much about ordering the expertise and agreed on the requirements when they provide offers for the project. You have to be pretty clear on what they want, and then there is the fact that we need a separate actor for the mapping of the materials and the reuse..."* that means that if the contractors don't want to reuse, for example, then they shouldn't be in this project.

I mentioned many changes that will affect the supply chain. To understand those better, I made a figure. Using figure 2 in chapter 2.2, where the theory showed how a classic supply chain would look like, I put in the changes that have appeared and will appear during this project, and usually every project where they try to reuse in the construction. This figure is made from my findings during the research, and probably not every project will be the same. At the same time, some of them are barriers and challenges in an early stage, so I would say that they will disappear or change after several pilot projects.

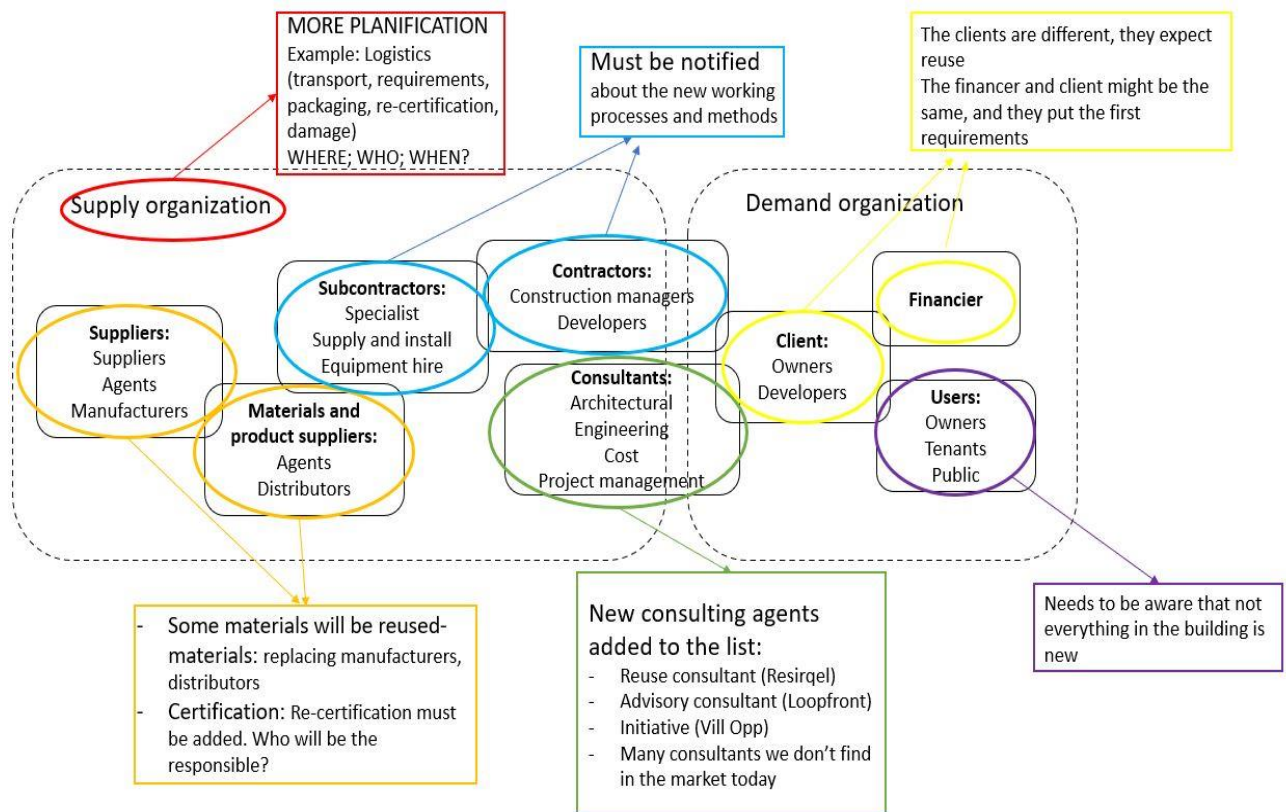


Figure 9 - How reuse affects the supply chain at the construction project

In the figure above, I tried to illustrate all the administrative areas discussed during this chapter. At the start, we find the suppliers, materials and product suppliers where we already see that reused materials will replace some materials; this leads to replacing the actual distributors and manufacturers. In the longer run, storage could become a material supply actor. Either by getting new ones for the reused materials or that they modify their mechanisms and starting working with reused materials too. On the other hand, the re-certification must be added to the supply chain. Today we had to get every material certified, but the actors responsible for the re-certification are something unknown yet.

Further, in the supply chain, we find contractors and subcontractors. I have already mentioned and discussed some of the barriers to reactions during chapter 5.1.2; they will be affected by the methods of work and procedures. Therefore, they should be notified about those changes before going into any deal. Supplementary to this, we find the consultants. I have mentioned two new partners and one initiative added to this project because they are needed for reuse. Firstly Resirqel, which did the mapping, and secondly, Loopfront, which sits with the database

and the initiative from Vill Opp where they want to be part of the warehouse. Probably, more consulting agents will need to be added to the list.

On the other hand, as we saw in chapter 5.1.1 about the drivers, some contractors and actors get motivated and want to improve. Like Informant 2 kept saying, *"I want to believe that there must be actors out there who want to be good on reuse and interested in making this happen. I believe in that, But the builder must know these two things when contracting. The first is that the builder must prioritise believing in it first so we can reach the goal and make each other believe in it. The second is to be clear on the order, what this project involves, and the actors who want to join the team. Just like in Kristian August Gate 13, there was a great interest from the suppliers to be part of the project."* We get from here that the motivation that drives innovation is a crucial part of wanting to make it possible. All the actors involved in the project have to know about the new requirements and agree on them before saying yes to being part of the project. And from other pilot projects, we know that there is motivation, and they believe in actors who want to join the team. At the same time, Informant 1 mentions a way of being sure that the requirements are going to be followed *"...we must now be focused on trusting each other, develop methodology and knowledge together. There will be a moment when it becomes precise with input, and then you have to put in some of what we call sanctions. If you do not do it, then commit. This project is ambitious and with some intentions, but there are no requirements yet. We must together find out how we can make the project work."* This informant mentions the sanctions. There are no requirements yet, so they haven't implemented anything like that. But at some point, the conditions will appear, and a method usually used in every industry is the sanctions. If the contractors know that they will be sanctioned if they don't do as agreed, then it is almost no way they will not do it like that. But the sanctions must come from the authorities, which leads to the next topic.

All of them together are part of the supply chain organisation. We have seen how every step will need to be modified. But in general, we can also find the logistics, where the transport, requirements, re-certification, packaging, and damage of the material are part of it. Those introduce questions like were who, and when that are still questions with no answers. Many of those acts come from above. Like Informant 1 said, *"...that comes from the top management. They have decided on a strategy for us to be the best at this. Then we will invest in it and spend a lot of money on development and research."*

On the other side of the organisation, we find the demand. In this project, Midtbygda, the client and the financier are the same, which is like this in many projects. At the start, the clients will be different than expected since they have to be searching for innovation in reusing materials which is something new. This also leads to integrating the clients into this equation. They should be aware that not everything in the building is unique. Many clients expect that today, and it shouldn't be something terrible, mind-changing.

With time and more pilot projects, there will appear more actors filling up the gaps, the time used for the planification will be reduced when a warehouse is in place and when they know who to consult if something happens, who can do the transport, what are the requirements and who can do the re-certifications. Those are examples of barriers that will be overcome by adjusting and making the circular supply chain of reusing materials more fluent.

5.3.1 The organisation at RCP

In this case, I didn't get the opportunity to know how the organisation for the planification or design phase of the project is since WBHO are contractors. As we have seen during the last chapter, and as I mentioned at the end, the contractors that are going to build and get affected by those requirements need to get notified about how they should do the job.

As Informant 7 told me, they got a list and the requirements they had to follow. The certification they want to reach is a six-star certification, and they got the requirements needed to get to that goal. But the informant kept saying, *"however, as a company, we have our own goals. First, we have the corporate responsibility for environmental failures. Because we have come a long way, we have got a system on-site."* When they are going to find a subcontractor, and they want to innovate, Informant 7 told us that *"... you need to submit to the credit professional, and that person who presented the council, then we score the client. So let's say in the design phase they haven't written the achievements for the credits, we can achieve the case under the socio-economic benefit, where we change the environment of where we are bowling, and we can do the innovative credit we find in schools or points."*, like in the BREEAM one of the credits they can get into the six-star is by innovation. Here the informant mentions that they do not always get all the information for getting all credits, but they can find their ways if they get the primary goal, like in this case, the six-star.

Further, they have a subcontractor that I have mentioned before: this is Ross Demolition. Informant 8 was telling us that *"So, we would get a project in Cape Town. Because most clients*

buy a piece of land and want to build on top of it, it is already a building there. We have to take this building down; we test our business, and we build up while Ross Demolition breaks down. So, we get them as a contractor. Normally, the agreement is that whatever they can shower, they can take out of the building, so we give the old site to them. They put off and demolish everything, taking out what they can from the buildings. Even the steel that is in the concrete columns, they take it out. And that would go to the salvage yard. From there, they would separate and put that into the second-hand shop for construction materials.” That is an excellent example of how an outside company, a new actor and a contractor can appear in the supply chain to make it circular. The organisation is straightforward, and they are its own company. They get the site to demolish and take whatever they want as long as the client doesn't specify something else. And when they finish, they deliver it back to the following contractors, who will build.

The clients and users of those used materials and furniture that Ross Demolition sells after sorting and cleaning are the market we are missing in Norway. They sell it to everybody; while it looks like in Bergen, they will start with just selling to construction companies, or it will stay within companies if the requirements get too harsh.

6. Summary and conclusion

This research study aims to observe different barriers and drivers that appear during the reuse of materials in a construction project. At the same time, I decided to look at the learning process and the organisation to understand better how some of those barriers can be overcome. Based on the above discussion, there is solid internal motivation for reuse, the authorities seem to be a great driver, the future profitability gives them hope, and the competencies guide most of the time the companies in the right way. These factors together form the company's motivation, resulting in the main drivers I found through my study.

But several barriers are slowing down the implementation, resulting in costs, time, authorities, price, re-certification, market/new actors, and logistics being the significant barriers. Out of those, I would say that the most mentioned during the interviews were the costs, the time and the logistics. Some barriers are easier to overcome, such as time. The more times we reuse and have pilot projects, the more fluently will the processes become, causing saving time, which also leads to reducing costs. Others are more difficult, like the re-certification, which is

connected to the authorities. Those barriers demand changing some rules and requirements, which are not made in one night. Some are at the firm level, as the price of the reused materials, and some at the system level, like the authorities I just mentioned. Therefore we can also expect the ones at the firm level to be easier to overcome.

6.1 Conclusion

This master thesis has aimed to uncover the drivers and barriers to reusing materials as a step towards a more circular economy in the construction industry. The main research question in this dissertation is "*What are the drivers and barriers of reusing material in the construction industry?*". Two sub-questions have been investigated to understand better these drivers and barriers, as well as some preliminary insights into how they may be overcome. The first one regards the learning process in the material reuse pilot projects that have been investigated for this thesis. In contrast, the second sub-question focuses on how the supply chain of a reuse construction project differs from that of a traditional construction project. These questions have been approached through a detailed qualitative investigation of the efforts towards reuse in the Midtbygda Sykehjem project in Bergen, Norway, and comparing reuse and waste handling in the River Club Project in Cape Town South Africa.

Through the empirical investigation, the most relevant drivers were the ones I mentioned before. The authorities have the power to start changes, use the money on pilot projects, and make initiatives. The competition between companies, concluding with the desire to be the first to innovate or the best, also inspires and drives to do the change. Then the inner motivation results in having the power to accelerate what many companies have already started thinking about, and the last one is the profitability. Like almost every industry, they are run by the money, and seeing the profitability at the end of it makes it easier to stay motivated. Those together are part of the company's motivation. Knowing the advantages and disadvantages can also help the company through innovation difficulties.

On the other hand, we find the barriers. I ended up with the seven walls mentioned before. While the authorities might be drivers, they also make reuse challenging because they encourage to innovate, but the requirements they set don't fit their desire to reuse materials. There are still many challenges to overcome, just like the re-certification, where we know that materials have to be certified before being used, but who will be responsible for re-certifying materials that have already been used? Or what is going to be the price of this material?

Further in the discussion is the market, no market of clients who wants to buy reused materials, and new actors such as consultants and subcontractors that have the knowledge to do this job. Those together will spend more time during the project, which is another barrier which causes more costs, since just having to use more time in a project means that more workers are needed to work longer. And it is not only the costs of the workers but also the new material and transport, etc.

Answering my first research question, implementing reuse in the construction industry will be challenging. The drivers make this innovation possible, but there are still many barriers that should be overcome. Both the drivers and barriers are at the system- and firm-level, which also makes a difference when trying to overcome the barriers. The ones at the system-level usually are the authorities who can make the change more manageable. At the same time, many of the firm-level barriers will be overcome with time, experience, and pilot projects.

The next chapter was about the learning process; the sub-question "*How is the learning process when implementing reuse of materials in a construction project?*" was aimed to provide more insight into the drivers and barriers. The discussion led to a lack of information flow, where persons only transport information, which can be risky for knowledge a person can bring. At the same time, the cooperation between states, municipalities, and companies is also limited, making workers do their research when innovating, even when other cities, states or companies have done it before. The following finding was that they don't have any database for all the information from a pilot project. This last one could solve many barriers, starting with the problems from the challenges just mentioned for the cooperation through companies, municipalities, and states. Persons wouldn't do the transport of information but through the database. And these together would possibly save a considerable amount of time, and costs, which are two main barriers at a firm-level.

The last chapter was about the organisation, where the sub-question was "*How will the supply chain be reorganised in circular construction projects?*". The question aimed to look at the supply chain of a construction project where they try to become circular. The most significant changes occur during the first phase when designing and planning. The suppliers will change since some of the materials are in place, other actors will probably do the re-certification, the consultants might be the same, but there will be added new ones, like Resirqel, Loopfront or Vill Opp have appeared in Midtbygda Sykehjem project. And at the end, the contractors and subcontractors need to get notified about how to work or do their job since there will be

procedures, processes and methods that need to be changed. Also, the users at the end of the construction need to know that it is not a building like many others expect, where everything is new. Those changes are not barriers, but most of the changes will be followed by extra time used, which, as mentioned, leads to costs. When the industry has done it several times, solved some challenges like making the consultants and the contractors know how to do their job, circular and the suppliers are in place, they will create a flow in the processes and probably use the same amount of time that in a traditional project where reuse is not part of it.

A good way of making the companies implement reuse and not being so scared is like informant 5 introduced, having the materials for free at the start and putting reuse requirements at the projects. There is a new BREEAM update in which reuse is part if they want to reach the "Excellent" level. The other way of reducing the CO2 is by demolishing less. But the organisation and learning process I was looking at gave me some solutions, and it has more pilot projects. Many barriers will be overcome, and then it will be more common and easy to reuse materials in construction projects.

Then, compared to the South African project, there are many differences. Firstly, which made it difficult to reach is that the RCP doesn't work with reuse. They recycle, which made possible some comparisons. Like the incentives or drivers, the authorities come with requirements, and the companies don't want to be left behind by the rest of the world. On the other hand, the barriers were more challenging to compare. But recycling is new for them. Ross Demolition has gone a step further than the Norwegian case by finding the market, actors, and procedures needed to reuse some building materials and furniture. Looking at the learning process of the recycling methods, they have come a long way. They are concerned about climate change, health, safety and the environment. Also, out of Ross Demolition, they have become better and found ways for cooperating that is favourable to everyone, but they still work a lot with papers which can be a bit chaotic. And the last one is the organisation, where it was also difficult to compare since they are contractors then. I couldn't look at the design phase, and Midtbygda Sykehjem hasn't come further. But they got told by the client how to work and the stars that they want to reach from the Green Council Certification. One of the factors I found had to be in place during the project in Norway. And the collaboration with Ross Demolition is also a great example of how to solve this challenge.

There are several strengths and weaknesses of collecting data from two different countries and projects. Some of the strengths could be that the points of view and opinions are other. And

even when there are two different ways of thinking, cultures and behaviours, the main goal of reducing CO2 and contributing to a better environmental future is the same. On the other hand, there are some weaknesses, like the generalisation when the information I got is from different countries. And it got even more complicated when the data collected was from two very other projects than the data required to be very careful when analysed.

6.1.1 Reflections

Analysing the empirical material also opened some theoretical reflections. When discussing the market, I mention it as several sectors in the project. It is not only the market that could buy the reused materials, but also the actors, finding consultants and subcontractors. This is an excellent example of changes in the formal institution. Those can contribute to changing the informal institutions (ways of thinking and norms). Sometimes they appear with new regulations where the population disagrees. Other times those new requirements change our attitudes. It was easy to see this in the project since the companies are targeting the goals set by the authorities.

The comparison between the Norwegian and the South African case showed that the market could be a significant barrier. Still, the articles I found consider markets as potential drivers for innovation and change. However, my cases show that when innovating for other than economic goals, like in this case, is for environmental purposes, and the markets may be a barrier.

Concerning the supply chain, it helped observe how functional the supply chain perspective is for understanding how a circular economy can be implemented. This tool should be used in more studies where searching for new models can make the implementation of reuse easier.

6.2 Limitations of the study

The focus was also on the barriers and drivers, while the learning process and organisation could be researched more in detail. The main project I collected data from was still in the design phase so I couldn't look at the whole project. The collected data was unbalanced. The data from the Norwegian case was much more than the South African. The time spent in South Africa limited my collection of data.

6.3 Avenues or further research

Firstly, as just mentioned, the main project in Norway was in the design phase, so it would be great to keep the research when they start demolishing and building again to see more barriers that could appear and changes in the organisation. I would also like to research the South African project and Ross Demolition. Maybe we had some more interviews with them and the project owners at Kristian August Gate 13.

On the other hand, this project was a qualitative study. I would also recommend doing quantitative research with a survey questionnaire where several workers in the industry could respond anonymously. This could give the study a review of other ways of thinking and points of view.

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Appendix

Attachment 1 – Interview guide in Norwegian

Intervjuguide

Hei, jeg heter Azul Mendivil og er en student på HVL. I forbindelse med min masteroppgave vil jeg utføre flere intervju.

Litt om bakgrunnen på denne masteroppgaven og meg, jeg er utdannet byggingeniør og nå tar jeg en master i innovasjon og entreprenørskap. Ved valg av master tema ville jeg koble sammen min forkunnskap med de nye kunnskapene. Innovasjon per i dag går i mange forskjellige retninger, men jeg synes selv det var interessant å satse på det grønne skiftet. Etter at jeg kom i kontakt med Skanska fant vi et prosjekt som var aktuelt for begge to hvor implementering av sirkulær økonomi i byggebransjen var hovedfokuset.

Jeg vil lære mer om implementering av nye tiltak, læringsprosessen, hvordan dere ansatte opplever endringer, vanskeligheter, osv.

Intervjuspørsmål:

BAKGRUNN TIL AKTØR

1. Hvor lenge har du jobbet på byggebransjen?
2. Yrkes og utdanningsbakgrunn
3. Hvilken stilling/oppgaver innen byggebransjen har du i dag? – Hva er forventningene fra bedriften i din stilling? Hva ser du for deg er ditt hovedfokus?

GENERELLE SPØRSMÅL - SELVTENKING

4. Hva betyr sirkulær økonomi?
5. Hvordan mener du at byggebransjen kan bidra til grønn omstilling?
6. Hvordan synes du at byggebransjen ligger an for å bli grønnere?
7. Har du sett implementering av tiltak som har noe med sirkulær økonomi å gjøre i byggebransjen? I så fall hvilke? Har dette endret seg over tid?
8. Ville du sagt at slike tiltak gjør noe forskjell? Hvordan?

SPESIFIKT OM BEDRIFTEN OG PROSJEKTET

9. Hvordan jobber Bergen Kommune mot en grønn omstilling i byggebransjen?
10. Kan du beskrive hva dere har gjort for å implementere ombruk i prosjektet?
- Hva er forskjellen fra et ombruksprosjekt til et vanlig prosjekt?
 - Har dere nye samarbeidspartnere som dere ikke har hatt før? Kunne du ha nevnt noen og oppgavene deres?
11. Hva synes du er vanskelig ved implementering av nye tiltak på planleggingsfasen?
Hvilke utfordringer har dere møtt ved å implementere ombruk i prosjektet?
- Hvordan har dere håndtert disse utfordringene?
 - Er det noe du ville ha gjort annerledes?
12. Hva synes du er vanskelig ved implementering av nye tiltak på konstruksjonsfasen?
- Hvordan har dere håndtert disse utfordringene?
 - Er det noe du ville ha gjort annerledes?
13. Hvordan tror du de fleste ansatt ville ha jobbet med de nye tiltakene?
- Hvilke ansatte blir påvirket av de nye tiltakene? Hvordan blir de påvirket?
 - Tror du alle som må gjøre noe annerledes kommer til å jobbe like godt mot det nye målet?

VEIEN VIDERE

14. Er det noe du synes jeg burde vite som jeg ikke har spurt om?
15. Er det andre jeg burde snakke med hvis jeg ønsker å finne ut mer om utfordringer ved implementering av ombruk i byggebransjen?

Attachment 2 – Interview guide, South Africa

Interview South Africa

Hi, my name is Azul Mendivil and I'm a student from Norway. I am writing my master thesis for my study which is Innovation and Entrepreneurship. Part of the thesis is doing some interviews to collect data.

About my thesis, I'm writing for a Swedish industry based in Norway called Skanska. I wanted to connect my knowledge from the civil engineer degree I got years ago, with the new knowledge of the master's. Skanska gave me an interesting project in the construction industry where they will try to reuse materials. There is a building standing on the site right now, and they are mapping the materials. In 2023 they will demolish the building to rebuild according to the new requirements.

What I want to know more about is implementing new measures, the learning process, how the employees experience the changes, barriers and difficulties, etc.

Interview questionnaire:

BACKGROUND OF THE INFORMANT

1. How long have you been working in the construction industry?
2. Vocational and educational background?
3. What position/ tasks do you have in the construction company today? Your expectations vs. your company's expectations from you. What is your focus?

GENERAL QUESTIONNAIRE

4. What is a circular economy?
5. Are you concerned with recycling? In that case, how?
6. How can the construction industry contribute to a green change?
7. How do you think the construction industry is poised to become greener?
8. Have you ever seen implementing measures for becoming circular in the construction industry? In that case which one? Has it changed with time?
9. Would you say that these measures make a change? How?

MORE SPECIFIC ABOUT YOUR INDUSTRY AND PROJECT

10. How does your company work towards a green transition? Do you see differences compared to other companies in the same industry?

11. Describe what you have done to implement reuse in the project.
 - a. What is the difference between a reuse project with a regular project?
 - b. Do you have new partners that you have not had before? Could you have mentioned some of them and their tasks?

12. What do you find difficult about implementing new measures in the planning phase? What challenges have you faced by implementing reuse in the project?
 - a. How have you handled these challenges?
 - b. Is there anything you would have done differently?

13. What do you find difficult about implementing new measures in the construction phase?
 - a. How have you handled these challenges?
 - b. Is there anything you would have done differently?

14. How do you think most employees will work on the new measures?
 - a. Which employees will be affected by the new measures? And how?
 - b. Do you think everyone who has to do something different will work equally well towards the new goal?

THE WAY FORWARD

15. Is there anything you think I should know that I have not asked?

16. Is there anyone I should talk to find out more about the challenges of implementing reuse in the construction industry?

Vil du delta i forskningsprosjektet

”Ombruk, gjenbruk og sirkulær økonomi i byggebransjen”?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å forstå hva og hvordan foregår implementering av tiltak som innebærer ombruk og gjenbruk i byggebransjen. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Prosjektet er en del av masteroppgaven min som inngår i masterprogrammet «Innovasjon og entreprenørskap» på Høgskulen på Vestlandet. Formålet med selve prosjektet er å forstå bedre hva og hvordan foregår implementering av nye tiltak i byggebransjen rettet mot en grønn omstilling. Hvor tiltaket jeg skal se på er implementering av ombruk.

Kort sagt har jeg en hovedproblemstilling som er:

«Hvordan byggebransjen kan ombruke og gjenbruke materialer på byggeplass?».

Og som igjen har tre delproblemstillinger:

1. *«Hvordan er organiseringer for å få slike tiltak til å fungere?»*
2. *«Drivere og barrierer ved implementering av slike tiltak.»*
3. *«Hvordan er læringsprosessen ved implementering av ombruk og gjenbruk av materialer på byggeplassen?»*

Hvem er ansvarlig for forskningsprosjektet?

Høgskulen på Vestlandet er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?

Utvalget er trukket fra interesse for forskningen. Interessegruppen er ansatte på byggebransjen som jobber mot et grønt skift. I denne oppgaven skal de være direkte knyttet til ombruk og gjenbruk og tiltak som innebærer implementering av de to sistnevnte.

Hva innebærer det for deg å delta?

Under denne masteroppgaven har jeg valgt å bruke kvalitativ metode. Med dette mener jeg undersøkelser som går i dybden for å også få informasjon om folks holdninger og tanker. Denne type metode egner seg godt når man skal undersøke spørsmål som omhandler *hva, hvorfor og hvordan*.

Gjennom studien vil det være aktuelt å holde en *konstruktivistisk epistemologi*, det er fordi studien gir oss muligheten til å holde et bredere syn og dypere forståelse for situasjonen i bransjen.

Denne metoden tar for seg metoder for datainnsamling som for eksempel intervju, dokumentanalyse og deltagende observasjon hvor de kan observere hele konteksten. Metoden er opptatt av å fortolke handlinger, tale og tekst og har fokus på prosesser og dynamikk.

Jeg vil dermed utføre noen intervju som blir tatt opp på lyd for videre transkribert hvor aktørene blir anonymisert.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg. Det vil ikke påvirke din behandling ved arbeidsplass eller arbeidsgiver.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrevet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- Det er kun den som blir intervjuet, og den som skal transkribere fra lyd til tekst, som skal ha tilgang til opptak av intervjuet. Disse blir slettet etter transkriberingen.
- Kollegaer fra prosjektet kan få tilgang til transkriberte intervju dersom de ønsker å sammenligne data.
- De transkriberte intervju skal kobles til bedrift eller prosjekt, ikke til person.
- Kontaktinformasjonen din vil bli lagret separat fra datamaterialet, på en minnepinne som ligger i et låst skap.

Publisering:

- Materialet blir brukt i vitenskapelig forskning.
- Sitat vil ikke kobles til navn, men du får likevel mulighet til sistatsjekk.
- Etersom konteksten du arbeider i har relativt få bedrifter og prosjekter kan ikke vi utelukke at du vil kunne bli gjenkjent av andre som kjenner konteksten.
- Informasjon som blir publisert vil omhandle temaet i prosjektet, altså ombruk i byggebransjen, og er ikke av personlig karakter.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er sommeren 2022.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Høgskulen på Vestlandet har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- Høgskulen på Vestlandet, ved Azul R. Mendivil. Azulr.mendivil@gmail.com eller

Nora Geirsdotter Bækkelund – ngba@hvl.no

- Vårt personvernombud: Trine Annikken Larsen

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen,
Azul R. Mendivil

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet [*sett inn tittel*], og har fått anledning til å stille spørsmål. Jeg samtykker til:

- å delta i intervju
- at opplysningene om bedriften og prosjektet kan publiseres slik at jeg vil kunne kjennes av andre som er kjent med konteksten

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

(Signert av prosjektdeltaker, dato)

|

Are you interested in taking part in the research project ***“Reuse and circular economy in the construction industry”***

This is an inquiry about participation in a research project where the main purpose is to investigate how sharing economy models help start-up companies at an early stage of development. In this context, we want to compare the offers available in Norway and South Africa. In this letter we will give you information about the purpose of the project and what your participation will involve.

Purpose of the project

The purpose of the project is to understand what and how we can implement new measures in the construction industry for a green change. Having focus on implementing reuse at the project.

Our research questions are as follows:

“How can the construction industry reuse materials in a construction project?”

“How is the organization that works for these measures?”

“Drivers and barriers of implementing such measures”

“How is the learning process of implementing measures where they reuse materials in the construction project?”

This project is in the form of a master's thesis and the final part of the master's program for Innovation and Entrepreneurship at the Western Norway University of Applied Sciences.

Who is responsible for the research project?

Western Norway University of Applied Sciences is the institution responsible for the project.

Why are you being asked to participate?

The selection for the data collection is based on companies and informants who are connected to the construction industry. The group of interest is employees at a construction project where they work for a green change. This project is connected to the reuse of materials and the implementation of processes for making it possible.

What does participation involve for you?

If you choose to participate in the project, it means that you participate in an interview that will take approx. 1 hour of your time. The questions will be about you and your experiences with reusing materials, as well as your company. If you allow this, audio recordings and notes from the interview will be taken. Then the audio recording will be transcribed. This transcript can, if desired, be sent to you afterwards so that you can have the opportunity to read through it for approval.

Participation is voluntary

Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data

We will only use your personal data for the purpose(s) specified in this information letter. We will process your personal data confidentially and in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

At Western Norway University of Applied Sciences, me and my supervisor Nora Geirsdotter Bækkelund will have access to the information.

In accordance with the guidelines at Western Norway University of Applied Sciences, the data material will be securely stored on our private PCs and we will ensure that no unauthorized persons have access to the information.

The participants will be able to be recognized indirectly in the publication by information about background and knowledge within the topic, but names will not be published. When using directly identifiable quotes, we will contact you for a quote check and permission to use this.

What will happen to your personal data at the end of the research project?

The information is anonymized when the project completed / the assignment is approved, which according to the plan is June 2022. At the end of the project, audio recordings will be deleted.

Your rights

So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?

We will process your personal data based on your consent.

Based on an agreement with Western Norway University of Applied Sciences, Data Protection Services has assessed that the processing of personal data in this project is in accordance with data protection legislation.

Where can I find out more?

If you have questions about the project, or want to exercise your rights, contact:

- Western Norway University of Applied Sciences, at Azul R. Mendivil
Azulr.mendivil@gmail.com or
- Nora Geirsdotter Bækkelund – ngba@hvl.no
- Our Data Protection Officer at Western Norway University of Applied Sciences: Trine Anikken Larsen, Trine.Anikken.Larsen@hvl.no
- Data Protection Services, by email: personverntjenester@nsd.no or by telephone: +47 53 21 15 00.

Yours sincerely,

Project Leader

Nora Geirsdotter Bækkelund

Student

Azul R. Mendivil

Consent form

Consent can be given in writing (including electronically) or orally. NB! You must be able to document/demonstrate that you have given information and gained consent from project participants i.e. from the people whose personal data you will be processing (data subjects). As a rule, we recommend written information and written consent.

- For written consent on paper you can use this template
- For written consent which is collected electronically, you must chose a procedure that will allow you to demonstrate that you have gained explicit consent (read more on our website)
- If the context dictates that you should give oral information and gain oral consent (e.g. for research in oral cultures or with people who are illiterate) we recommend that you make a sound recording of the information and consent.

If a parent/guardian will give consent on behalf of their child or someone without the capacity to consent, you must adjust this information accordingly. Remember that the name of the participant must be included.

Adjust the checkboxes in accordance with participation in your project. It is possible to use bullet points instead of checkboxes. However, if you intend to process special categories of personal data (sensitive personal data) and/or one of the last four points in the list below is applicable to your project, we recommend that you use checkboxes. This because of the requirement of explicit consent.

I have received and understood information about the project [*insert project title*] and have been given the opportunity to ask questions. I give consent:

- to participate in (*insert method, e.g. an interview*)
- to participate in (*insert other methods, e.g. an online survey*) – if applicable
- for my/my child's teacher to give information about me/my child to this project (*include the type of information*)– if applicable
- for my personal data to be processed outside the EU – if applicable
- for information about me/myself to be published in a way that I can be recognised (*describe in more detail*)– if applicable
- for my personal data to be stored after the end of the project for (*insert purpose of storage e.g. follow-up studies*) – if applicable

I give consent for my personal data to be processed until the end date of the project, approx. [*insert date*]

(Signed by participant, date)