



**LTH**  
FACULTY OF  
ENGINEERING

# MARKET FOR REUSE

Investigating reuse of acoustic ceilings

from a market perspective

DEGREE PROJECT IN PRODUCTION MANAGEMENT

*By:*

Anton Gunnarsson & Oscar Nilsson

**Ecophon**  
SAINT-GOBAIN

Degree Project in Production Management MIOM05  
Division of Production Management  
Lund University  
Faculty of Engineering

June 2023

Supervisor at Lund University: Bertil Nilsson

Supervisor at Saint-Gobian Ecophon: Elie Falcand

Examiner: Ola Alexandersson

©2023 Anton Gunnarsson & Oscar Nilsson. All rights reserved.

## Acknowledgements

This master's thesis concludes the students' educations, providing both with a Master of Science degree in Electrical Engineering. This research project constitutes 30 ECTS and has been conducted at the Division of Production Management at Lund University, Faculty of Engineering. Both students have been involved in all processes in the master's thesis project.

Firstly, we would like to thank our supervisor at the Division of Production Management Bertil Nilsson for supporting us throughout the entire project and helping guide us towards the right direction. His enthusiasm and interest in our work have truly been an inspiration to us.

We would also like to thank our supervisor at Saint-Gobain Ecophon Elie Falcand for his support and insights during the project. The interesting discussions and meetings always inspired us to do our best while also giving us the opportunity to shape the thesis in our own preferable way.

Furthermore, we would like to thank Saint-Gobain Ecophon for giving us this opportunity and a big thank you to all the interviewees who made this research project possible to conduct.

We would like to thank our friends and family for the constant support during this period and a special thanks to our fathers Anders Gunnarsson and Jörgen Nilsson for providing us with interviewee contact information and general insights in the construction industry.

Lastly, we want to thank each other for always pushing one another to the best of our efforts throughout our entire education.

Lund, June 2023



Anton Gunnarsson



Oscar Nilsson



# **Abstract**

## **Title**

Market for Reuse - Investigating reuse of acoustic ceilings from a market perspective

## **Authors**

Anton Gunnarsson & Oscar Nilsson

## **Supervisors**

Bertil Nilsson, supervisor at Lund University

Elie Falcand, supervisor at Saint-Gobain Ecophon

## **Context**

Today, 96% of Sweden's materials come from virgin resources and only 3.4% of resources used in Sweden are retained in the value chain. From a total of 266 million tonnes fed into the economy each year, 46.9% consist of construction materials. Hence, there is a need to adapt circular strategies, such as reuse of construction products, to meet Sweden's goal of becoming net zero by the year 2045.

## **Purpose**

To face the problem of extensive construction material waste, there is a need to identify drivers and barriers for reuse of construction products to establish a best practice for the case company in developing a market for reuse.

## **Method**

This research is designed as a mix of an explanatory study and a problem solving study, using case studies. The research approach used is abductive, using qualitative data from a literature review and interviews with stakeholders to gather information.

## **Conclusions**

The drivers and barriers for reuse could be identified as e.g. high demand, GBC:s and reuse being considered as a trend. By using the DIBN-framework, recommendations on how the case company could move forward with a general offer, short term focus and long term focus could be determined. The recommendations show key aspects to be considered when establishing a market for reuse, such as marketing towards real estate companies using GBC:s as a marketing tool and incentivising demolition companies to perform selective demolition projects. Key aspects such as quality and simplicity were also discovered as a high priority when purchasing reused acoustic ceilings, hence quality testing and a simple and efficient RL-system needs to be set up and optimised to enable long term success with the market for reuse innovation.

## **Keywords**

Green Building Certifications, Circular Economy, Circular Logistics, Circular Marketing, Construction Product Regulation, Management, Reuse, Reverse Logistics

## **Abbreviations**

<b>CPR</b>	Construction Product Regulation
<b>DIBN</b>	Drivers Inbetweeners Barriers and Needs
<b>EoL</b>	End-of-Life
<b>EPD</b>	Environmental Product Declarations
<b>FL</b>	Forward Logistics
<b>GBC</b>	Green Building Certification
<b>GC</b>	General Contracting
<b>KPI</b>	Key Performance Indicator
<b>RL</b>	Reverse Logistics





# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Background & context . . . . .	1
1.1.1	The introduction of circular economy . . . . .	1
1.1.2	The concept of reuse . . . . .	2
1.1.3	Case company . . . . .	3
1.2	Problem & task description . . . . .	3
1.3	Purpose & project objective . . . . .	4
1.4	Delimitations . . . . .	5
1.5	Disposition . . . . .	5
<b>2</b>	<b>Method</b>	<b>7</b>
2.1	Research design . . . . .	7
2.2	Research approach . . . . .	9
2.2.1	Inductive, deductive and abductive research approaches . . . . .	9
2.2.2	Qualitative and quantitative research . . . . .	10
2.2.3	Research process . . . . .	11
2.3	Data collection . . . . .	13
2.3.1	Literature review . . . . .	13
2.3.2	Interviews . . . . .	13
2.4	Validity & reliability . . . . .	17
<b>3</b>	<b>Theory</b>	<b>21</b>
3.1	Circular economy . . . . .	21
3.1.1	The three principles of circular economy . . . . .	21
3.1.2	The 9R framework . . . . .	23
3.2	Circular logistics . . . . .	25
3.2.1	Circular supply chains . . . . .	25
3.2.2	The marketing mix for circular logistics . . . . .	27
3.2.3	Reverse logistics . . . . .	29
3.3	Initiatives towards sustainable construction . . . . .	34
3.3.1	Construction products regulation . . . . .	34
3.3.2	CE-marking for construction products . . . . .	36
3.3.3	Boverket . . . . .	37

3.3.4	Environmental product declaration . . . . .	37
3.3.5	Other initiatives towards sustainable construction . . . . .	38
3.4	Certifications . . . . .	38
3.4.1	Certification systems in Sweden . . . . .	38
3.4.2	LEED . . . . .	39
3.4.3	Miljöbyggnad . . . . .	40
3.4.4	BREEAM-SE . . . . .	41
3.5	Management & behaviour . . . . .	43
<b>4</b>	<b>Empirics</b>	<b>49</b>
4.1	Internal interviews . . . . .	49
4.1.1	Perception and knowledge of sustainability . . . . .	49
4.1.2	The construction market . . . . .	51
4.1.3	Pricing and assurances . . . . .	53
4.1.4	Regulations . . . . .	54
4.1.5	Future visions . . . . .	54
4.2	External interviews - planning phase . . . . .	55
4.2.1	Perception and knowledge of sustainability . . . . .	55
4.2.2	Current practices on reuse . . . . .	60
4.2.3	Considered aspects for reuse . . . . .	64
4.2.4	Project influence . . . . .	67
4.2.5	Drivers and barriers . . . . .	69
4.2.6	Future visions and ideas . . . . .	73
4.3	External interviews - implementation phase . . . . .	76
4.3.1	Perception and knowledge of sustainability . . . . .	76
4.3.2	Current practices and aspects for reuse . . . . .	78
4.3.3	Project influence . . . . .	82
4.3.4	Future expectations and ideas . . . . .	83
4.4	Typical stakeholders . . . . .	85
4.4.1	A typical internal stakeholder . . . . .	85
4.4.2	A typical planning phase stakeholder . . . . .	85
4.4.3	Typical implementation phase stakeholders . . . . .	86
4.5	Literature review . . . . .	88

<b>5</b>	<b>Analysis</b>	<b>91</b>
5.1	Analytical framework . . . . .	91
5.2	Drivers . . . . .	92
5.3	Inbetweeners . . . . .	94
5.4	Barriers . . . . .	95
5.5	Needs . . . . .	96
5.6	Industry gaps . . . . .	98
<b>6</b>	<b>Proposition &amp; Conclusions</b>	<b>101</b>
6.1	Recommendations . . . . .	101
6.1.1	Case company-specific recommendations . . . . .	101
6.1.2	The general offer . . . . .	102
6.1.3	Short term focus . . . . .	104
6.1.4	Long term focus . . . . .	106
6.2	Connection to research questions . . . . .	107
6.3	Contributions . . . . .	108
6.4	Future work . . . . .	109
	<b>References</b>	<b>a</b>
	<b>Appendices</b>	<b>g</b>
	Appendix A: List of interviewees . . . . .	g
	Appendix B: Interview guide: Internal stakeholders . . . . .	h
	Appendix C: Interview guide: Planning phase . . . . .	k
	Appendix D: Interview guide: Implementation phase . . . . .	o



# I Introduction

*In this chapter the background and the context will be introduced. The concept of reuse and the case company chosen for this thesis are presented as well. Thereafter the problem and task description are described which leads into the purpose and project objective. The delimitations are then described while lastly the disposition of the thesis is presented.*

## I.1 Background & context

### I.1.1 The introduction of circular economy

In the current economy, materials are taken from the Earth to create products that eventually are thrown away as waste - a linear process. In a circular economy, by contrast, waste is never produced in the first place [Ellen MacArthur Foundation, 2023a].

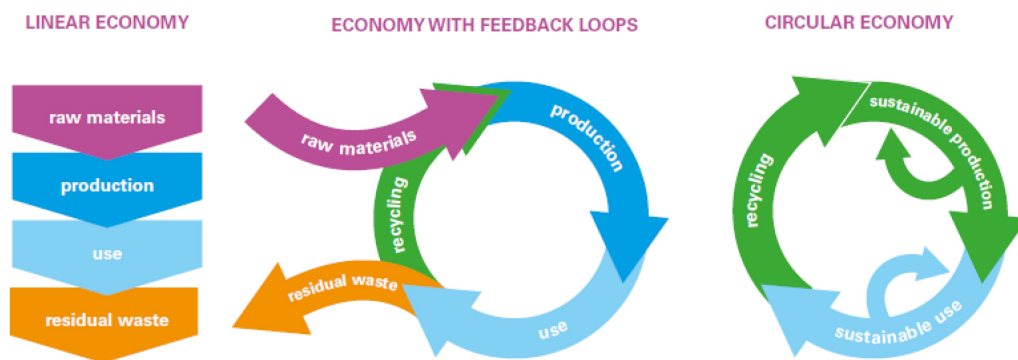


Figure 1: Linear, circular and economy with feedback loops [Van Buren et al., 2016]

As can be seen in figure 1, the raw material input is no longer evident for a circular economy and loops are closed. The vision is therefore to transform all elements of the take-make-waste system by managing available resources, rethinking the way products are produced and used as well as figuring out what to do with products

and materials after they have been used. A proper transition enables growth in prosperity and jobs while also reducing greenhouse gas emissions, pollution and waste [Van Buren et al., 2016, Ellen MacArthur Foundation, 2023a].

Along with the vision, the first circular economy action plan was introduced by the European Commission in December 2015 and has been revised up until November 2022 with newly adopted proposals and measures with the objective of making sustainable products the norm in the EU, ensuring less waste and make circularity work for people, regions and cities. The European Commission proposes 35 actions, where one of the actions focused on concerns circularity in construction and buildings [European Commission, 2023a].

In order to reach the goals concerning circularity in construction and buildings, the circular economy action plan highlights the Construction Product Regulation (CPR) as a part of efforts towards a more energy- and resource-efficient construction industry, addressing the sustainability of construction products. The CPR proposes several options for revision, where the promotion of reusing construction products is an action aimed at addressing this highlighted issue [European Commission, 2022].

### **1.1.2 The concept of reuse**

*Reuse* refers to the using-again of an object, a product or substance for the same purpose as it was originally designed for, without the need for repair or refurbishment. Users are encouraging the production side to offer products or materials that are more robust and hence fostering more sustainable consumption and production patterns [UNEP, 2023].

Compared to recycling, reuse is often preferred in aspects of energy and environment, since reuse requires less energy and resources than recycling. Reuse also prevents products or materials from becoming waste, thus helping to reduce environmental footprints caused by pollution [Safeopedia, 2017].

### **1.1.3 Case company**

As reuse is becoming a trend in the construction industry, the company Saint-Gobain Ecophon showed an interest in becoming the specific case company for this study. Since the case company sought after was supposed to be a manufacturer of construction products located in Sweden, Saint-Gobain Ecophon and was chosen as the case company for this research project, since they met the requirements. Saint-Gobain Ecophon is also a highly innovative company that is ready to move forward with new ideas and innovations.

Saint-Gobain Ecophon, a part of the Saint-Gobain group, develops and manufactures acoustic products, systems and solutions to contribute to a good working environment. The company promise is "A sound effect on people" and is the core of Saint-Gobain Ecophon. The company has a headquarters located in Hyllinge, Helsingborg, business units in 20 countries, delegations in 30 countries worldwide and approximately 1100 employees [Ecophon, 2023a]. Sales are made through a traditional salesperson and the company does not currently employ e-commerce for any of their sales.

Sustainability is an important factor for Saint-Gobain Ecophon and reaching true net zero emissions by not emitting more carbon dioxide than can be absorbed by the year 2050 is an active goal within the organisation. To reach the goal of net zero emissions, innovation is needed both for their current products, but also in more radical ways through material usage, process changes and partnerships. One of the keys for this is to integrate the R&D department fully to focus on environmental aspects for technologies and processes by the year 2025 [Ecophon, 2023b].

## **1.2 Problem & task description**

Today, 96% of Sweden's materials come from *virgin* resources, i.e. raw material, and only 3.4% of resources used in Sweden are retained in the value chain. The latest Circularity Gap Report found that 266 million tonnes are fed into the Swedish economy each year whereas 46.9%, or 125 million tonnes, of this consist of construction materials. Hence, there is a need to adapt different strategies in

circular economy in the construction industry to contribute to Sweden's emission goal of becoming net-zero by 2045 [Circle Economy, 2022].

To reduce the number of virgin resources used in the construction industry, the usage of *secondary resources* in new construction, e.g. reused construction material, has been identified as a strategy for keeping track of the building stock expansion [Circle Economy, 2022].

The case company has also identified an unexploited value concerning reuse in the acoustic ceilings business. By suggesting a set of measures and activities increasing the share of reuse, this value can be captured. Through the usage of the methods presented in chapter 2, drivers and barriers for reuse can be identified, whereas a driver in this thesis can be explained as a driving force towards new innovations, such as establishing a market for reuse, and a barrier can be explained as something preventing the establishment of the innovation. Along with the drivers and barriers, the industry gaps around reuse will become evident as well, whereas an industry gap in this thesis can be described as differences in perceptions, wants and needs both internally in a business and between different businesses. These findings should all be presented to enable long-term success for the potential market for reuse in a circular business.

### **1.3 Purpose & project objective**

To face the problem and task described in chapter 1.2 there is a need to identify the drivers and the barriers of reuse in the acoustic ceilings business to be able to define a possible best practice for the case company. Hence, the following research questions have been defined as the objectives for this master thesis project:

- **RQ1:** What are the driving forces that incentivises reuse of acoustic ceilings?
- **RQ2:** What are the barriers preventing reuse of acoustic ceilings in the construction industry?
- **RQ3:** How should a possible best practice for the case company be



described with the aid of existing theories and empirics discovered on the studied topics?

Finding answers to the presented research questions could form a baseline for introducing reused material as an option in the construction material market, contributing to the net-zero emission goal in Sweden.

#### **1.4 Delimitations**

The delimitations for this thesis are set to make sure the scope does not become too wide. The first delimitation includes the analysis of acoustic ceilings only, and more specifically acoustic ceiling tiles and not the entire ceiling system with grid systems. Therefore, when the term acoustic ceilings are used, only the acoustic ceiling *tiles* are implied.

This thesis will also not cover detailed logistical aspects concerning packaging, warehousing or inventory management of reused acoustic ceilings and instead focus more on strategic circular logistical aspects.

The research is also *limited* to only concern the Swedish construction market due to the scope of this research.

#### **1.5 Disposition**

The *Introduction* chapter introduces the background and context as well as the problem and task description. The purpose and project objective are also described and delimitations are introduced and presented.

The *Method* chapter describes the method and research approach for this thesis. The research approach, research design and the data collection method is presented to answer the research questions. Furthermore, the validity and reliability are presented for this thesis as well.

The *Theory* chapter is based on a literature review. The topics include circular economy and details on circular logistics, as well as legal aspects and

certifications. Lastly, the topic of management and behaviour is mentioned.

The *Empirics* chapter includes the information gathered through the interviews as well as relevant data found in the literature review. The information from the internal interviews is first introduced, and then the information from the external interviews follows. Lastly, the gathered empirical information from the literature review is described.

The *Analysis* chapter introduces the analytical framework created by the authors and an analysis is made on the drivers, inbetweeners, barriers and needs. The industry gaps are also analysed.

The *Conclusions* chapter presents the recommendations for the case company and the connection to the research questions. The contributions as well as future work is later discussed as well.

## 2 Method

*In this chapter the methodology used for the master thesis will be presented. Firstly, the research design is brought up followed by the research approach, discussing different approaches as well as providing the framework for the research process used in this thesis. Following the research approach, data collection will be discussed in terms of information gathering and validity and reliability will be brought up to evaluate the scientific value of the research.*

### 2.1 Research design

The research design means to define the frames and principles of how the project will be carried out. It describes the steps that will be taken towards increased knowledge on the subject originating from the overall goal, rather than specific actions needed or not needed to reach the goal of the master's thesis [Höst et al., 2006].

What type of study used depends on the characteristics and goal of the project. The purpose of the project can be divided into [Höst et al., 2006]:

- *Descriptive studies*, with the aim to find out and describe how something works or is conducted.
- *Exploratory studies*, with the aim to deeply look into how something works or is conducted.
- *Explanatory studies*, with the aim to seek causation and explanations on how something works or is conducted.
- *Problem-solving studies*, with the aim to find a solution to an identified problem.

At a technical university, problem-solving studies are the most common. However, a combination of several studies is often used when the study is divided into several partial studies. A problem could be identified as part of a descriptive or exploratory study that will be solved in a partial problem-solving study [Höst et al., 2006].

Once the research design has been determined, the research method and different tools to be used in the research should be considered [Höst et al., 2006]. The four most relevant methods for a master thesis are:

- *Surveys*, which is a compilation and description of the current situation concerning the studied object or phenomena. It is usually used to describe wider questions.
- *Case studies*, which is a deep study of one or several cases, where the researchers try to influence the study as little as possible.
- *Experiments*, which is a comparative analysis of two or more alternatives, where the researcher tries to isolate a small number of factors and manipulates one of them.
- *Action research*, which is a careful monitoring and documented study of an activity that aims to solve a problem.

Surveys and experiments are treated as fixed methods, meaning e.g. question forms in a survey can not be changed, since answers would become incomparable. For action research and case studies, flexible methods are more prevalent. Here, tools can be continuously adaptable to match altered changes during the study [Höst et al., 2006].

In the first stage, the study is designed as an explanatory study since the aim is to find the gaps between the current and a desired state by identifying barriers and drivers to help find causation. This will mainly be done through desktop surveys and internal interviews. For the second stage, a problem-solving study will be used to fill the gaps as well as find a best practice for the case company through a case study method.

The case study method is chosen since this method is relevant when the question requires a description of a social phenomenon [Yin, 2014], such as drivers and barriers for reuse. The case study method is also chosen since deeper knowledge is needed and is used to understand the complex situation regarding different perceptions of sustainable topics in the construction industry.

## **2.2 Research approach**

### **2.2.1 Inductive, deductive and abductive research approaches**

Different research approaches contribute in different ways to theory building. The research approaches relevant for a master thesis are *inductive*, *deductive* and *abductive* and they differ in the way the paradigms interpretivism, scientific realism and positivism are applicable [Kovács and Spens, 2007].

When using an inductive approach, the process starts either with a specific empirical case or a collection of observations that may lead to emerging theories and their generalisation in a theoretical framework. The path starts from a case to a rule and finally to a result. A generalisation might however not be the purpose of all inductive approaches, since some aim to show subjective varieties in a phenomenon. Issues concerned with inductive research usually point to the inability to establish new theories, because once a proposition or a theory is rejected, the approach lacks the power of modifying action. Inductive research may use both qualitative and quantitative methods, hence the inductive approach is appropriate e.g. recontextualising or reinterpreting data from a previous study [Kovács and Spens, 2007].

Deductive research uses the opposite approach of inductive research, starting from theoretical advances and following up on empirical testing. The path goes from a rule, to a case and finally to a result. Usually, the approach begins with logical conclusions derived from theory and is then presented with either hypotheses or propositions. These hypotheses or propositions are tested subsequently in an empirical surrounding and conclusions can then be drawn concerning corroboration and falsification of the main hypotheses or proposition. Like the inductive approach, the deductive approach also has issues establishing new theories but instead modifies or refines them. This approach qualifies as theory building by creating new hypotheses that are logically deduced from theory. Methods used for data collection range from quantitative simulations and statistical surveys to structured qualitative interviews and the purpose of the deductive research approach can either be predicative or propositional [Kovács and Spens, 2007].

Abductive research approaches can be conducted in two ways. Firstly, the researcher makes an empirical discovery of a phenomenon that deviates from theoretical frameworks that have been previously used and challenge the usability of that specific framework. A search for matching theories is conducted to explain the observation that was deviating from the original theory. Secondly, the researcher applies a new theory or framework to existing observations. Theories from other examples are borrowed to initiate abductive research, hence implying a belief in the possible coexistence of theories. The purpose of an abductive research approach is to understand a new phenomenon and propose new theories applicable to it. Unlike inductive and deductive research approaches, the abductive research approach is known as the most creative when it comes to creating new theories. Therefore, it is best suited for the revolutionary phase of theory building [Kovács and Spens, 2007].

While the aim of a deductive research approach is testing or evaluating a theory, both induction and abduction aim to develop it. However, the primary aim of the abductive approach is not just to develop a theory "but to develop an understanding of a 'new' phenomenon" [Kovács and Spens, 2005]. It is argued that abductive reasoning is very commonly used for both case studies and action research, due to simultaneous data collection and theory development that lies in the nature of an abductive approach [Kovács and Spens, 2005].

For this thesis, an abductive research approach will be used since data collection and theory development will happen simultaneously. Best practices on reuse and circular economy from areas in the construction industry will be studied to initiate the research and find possible answers to **RQ1** and **RQ2** that might coexist for this specific case study. Since the purpose of an abductive approach is to understand new phenomena and propose new theories applicable to them, this research approach is also well suited to answer **RQ3**.

### **2.2.2 Qualitative and quantitative research**

Research is split into qualitative or quantitative approaches depending on the data gathered and the goal of the thesis [Höst et al., 2006]. A case study can also contain quantitative data, qualitative data or both [Yin, 2014].

Qualitative research is done in a natural, often uncontrolled environment, to find the meaning behind a certain behaviour, usually from the point of view of the studied persons. The research is also described to be a process-oriented research method where information and data gathering is adapted to the empirics [Bryman and Bell, 2015]. Qualitative data is descriptions, words and concepts that are used to derive a deeper analysis of the subject [Bryman and Bell, 2015, Höst et al., 2006].

Quantitative research and data use numbers where theories and concepts are tested on reality [Bryman and Bell, 2015, Höst et al., 2006]. Commonly, the theoretical part is done before the empirical data is collected. Quantitative research is done to find behaviours and the research is set up in a controlled environment where the researcher is less involved in the data collection compared to a qualitative researcher [Bryman and Bell, 2015].

This thesis will use a qualitative research approach to answer the research questions since understanding the drivers and barriers of the market stakeholders is key. The meaning behind the behaviour of the stakeholders is an important aspect to include and therefore data collection will be done in an environment where the stakeholders can feel open to explain their thoughts.

### **2.2.3 Research process**

The research process for this thesis can be seen in figure 2 and follows an abductive research approach, as defined in chapter 2.2.1.

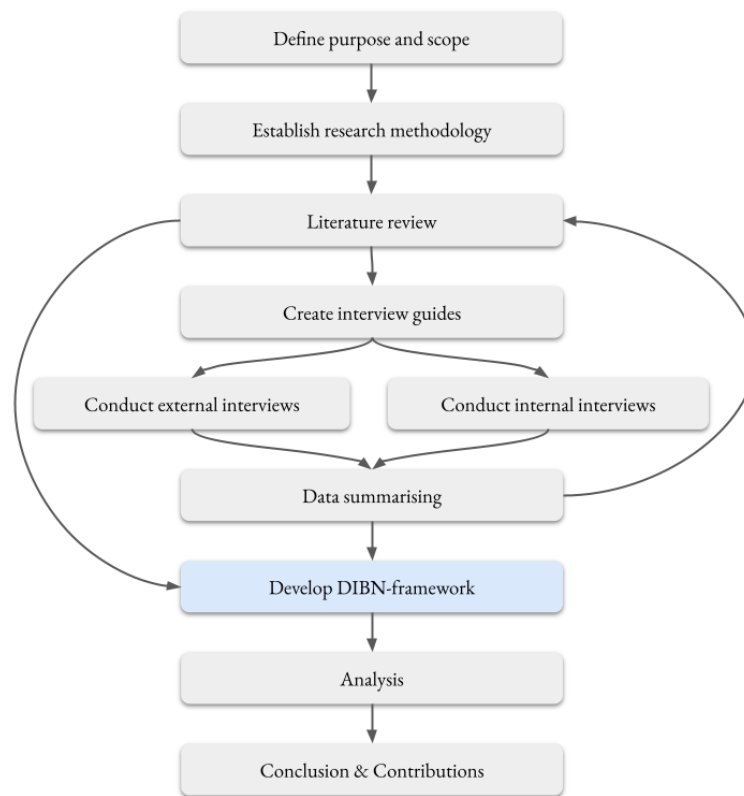


Figure 2: The research process, own work

The process starts with defining the purpose and scope of the research. Once the scope and purpose is defined, the research methodology is established and the literature review will begin to find an understanding of what question are relevant to include when creating the interview guides. Following the creation of interview guides, the internal and external interviews will be conducted and the data will be summarised and compared to the existing literature review. This is also where new aspects in literature might become relevant and will therefore be researched to be able to develop the DIBN-framework (Drivers, Inbetweeners, Barriers and Needs-framework), which is a framework created by the authors and presented in more detail in chapter 5.1. Finally, an analysis will follow to enable a conclusion of the thesis as well as establish contributions to the academics.



## **2.3 Data collection**

### **2.3.1 Literature review**

To formulate relevant questions and set the scope of the project, a literature review can be conducted. A literature review is therefore not only relevant when gathering theory and relevant information, but to gain an insight into the topic [Höst et al., 2006, Yin, 2014]. The literature review process is an iterative process as more knowledge is gained throughout the review of literature and keywords and deep dives into relevant theory can be done. This means the literature review will be a process throughout the entirety of the thesis to continuously gain new knowledge and insights to ensure greater results while connecting it to the empirics [Höst et al., 2006].

The main tools to search for material will be LUBsearch and Google Scholar. The material will also be found through Lund University Library and with the help of the supervisor at Lund University. Internal material from the case company will be obtained with the help of the supervisor at the case company.

The document types reviewed were white paper articles, tech reports, academic journals, manuals, government reports, textbooks and reference books.

Keywords were documented during the search process to organise and to be able to track the process [Höst et al., 2006]. The keywords used were the following; *circular economy, reuse, circular logistics, reverse logistics, CPR, CE-marking and green building certifications.*

### **2.3.2 Interviews**

Interviews are of importance during this thesis since the study design is through a case study method involving human affairs and actions [Yin, 2014]. There are three different types of case study interviews:

- *Prolonged interviews*, which are interviews that take over two hours where the interviewee is asked about their interpretations, opinions or insights on a deeper level, but in a conversational manner.

- *Shorter interviews*, which are focused interviews and take around an hour to complete. These types of interviews are more likely to follow a case study protocol to a higher degree than prolonged interviews.
- *Survey interviews*, which are interviews following a strict questionnaire to gather quantitative data.

The interview type that will be used is the shorter case study interview. This is due to the more focused nature of it compared to the prolonged interview, as well as to gather qualitative data and not quantitative data. Important to consider during the shorter case study interview is to keep the questions neutral and non-leading to not receive inaccurate information [Yin, 2014].

Different structures of the interviews are also of relevance. The three different structure types are *unstructured*, *semi-structured* and *structured* [Höst et al., 2006].

The unstructured interview structure is an open interview closer to a conversation. The goal of an unstructured interview is to describe the interviewee's experiences within the chosen subjects while the purpose is often of exploratory nature [Höst et al., 2006].

Structured interviews are interviews using set questions with set answers where the goal is to gain knowledge of relations between concepts and find connections. This interview structure is of an explanatory nature [Höst et al., 2006].

The semi-structured is a mix of unstructured and structured interview structures. The questions within this structure are set to be both open within the subject, and also questions with set answers. Important to highlight is the need to ask the set questions in the same order during every interview to not create bias [Höst et al., 2006].

An interview is also split into four different phases and is the following [Höst et al., 2006]:

- *Context*, which is the start of the interview where the interviewer explains the context, and the purpose as well as asks for consent to record or use their name or position in the thesis afterwards.

- *Introductory questions*, is the phase with neutral questions like the interviewee's age and position to help the interviewee to get comfortable early during the interview.
- *Main questions*, which is the phase where the main questions on the relevant topic are asked. These questions should be in a logical order, while the questions closer to the end should be more neutral again to create a positive atmosphere to be able to receive feedback and continue to stay in contact for follow-up questions.
- *Summary* is the last phase of the interview where the interview is summarised for the interviewee and they are asked to add anything if they feel something was left out. The context is repeated once again and the interviewee is thanked for their participation.

The interview structure that will be used for this thesis is semi-structured to be able to describe the market for reuse and gain data relevant to answer the research questions at hand. This since in this thesis, a market and its drivers and barriers will be based on the opinions of the relevant stakeholders and the interviewee has to be able to answer openly to express themselves. Other questions are simple questions to test the interviewee's knowledge on the topic of reuse. The four phases mentioned will be used as a basis for the structure used for the question forms and can be seen in the interview guides in *Appendix B, C and D*, with an addition of a filter question, with the purpose to reduce respondent burden and not waste the researcher's or the participant's time in collecting meaningless data [Allen, 2017]. It is also worth mentioning questions deemed irrelevant for a specific company role are not asked during interviews. Questions are always asked in the order they appear in the question forms but can sometimes be rephrased if needed.

The interviewees that will be picked for the interviews for this thesis can be split up into external stakeholders and internal stakeholders for the case company. A list of all interviewed stakeholders can be seen in table 2 in *Appendix A*. The position of these stakeholders can be seen in figure 3 and was selected by a discussion with supervisors and through findings from the literature review. The external stakeholders can further be divided into *planning phase stakeholders*

and *implementation phase stakeholders*. This is done since the planning phase stakeholders are stakeholders who plan the construction project and operates at a different level compared to the implementation phase stakeholders, who is the stakeholder who is relevant for implementing, using and buying or selling the reused ceiling tiles directly. Different interview guides will be used for the different types of interviewees, and can, as earlier mentioned, be seen in *Appendix B, C and D*. The reason behind using different interview guides for different stakeholders is that questions deemed relevant for specific stakeholders will differ depending on their positioning in the stakeholder framework seen in figure 3.

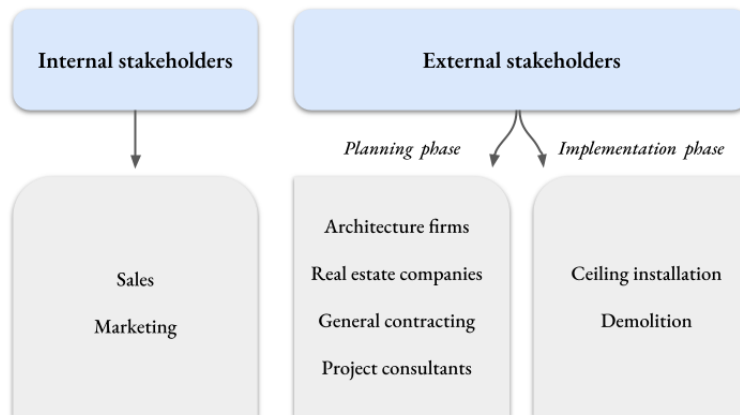


Figure 3: All types of interviewed stakeholders, own work

The contacts for the internal stakeholders will be acquired with the help of the case company's supervisor. The internal ones will also act as a link to the external ones and bring information and data about the customer from the point of view of the case company. Through the internal contacts, external interviewees and contacts will be established to continue the interview process and gain relevant data. External stakeholders will also be gathered with the help of the supervisor at Lund University and through contacts and research of the authors. The reason for not only contacting external stakeholders provided by the case company is to minimise biasing and gain a broader view of the market, enabling further insights.

## 2.4 Validity & reliability

The quality of any given design can be judged according to a set of logical tests, as presented in table 1. These tests are relevant for both qualitative and quantitative research [Bryman and Bell, 2015].

Table 1: Case Study Tactics for Four Design Tests, adapted from [Yin, 2014]

Tests	Case Study Tactic	Phase of Research in which Tactic Occurs
<i>External validity</i>	• use theory in single-case studies	- research design
	• use replication logic in multiple-case studies	- research design
<i>Construct validity</i>	• use multiple sources of evidence	- data collection
	• establish chain of evidence	- data collection
	• review draft case study report	- composition
<i>Reliability</i>	• use case study protocol	- data collection
	• develop case study database	- data collection
<i>Internal validity</i>	• do pattern matching	- data analysis
	• do explanation building	- data analysis
	• address rival explanations	- data analysis
	• use logical models	- data analysis

*External validity* deals with the question if a study's finding can be generalised beyond the direct studied phenomenon, regardless if the research method is e.g. experimental, survey based or a case study. Specifically for case studies however, the issue relates to analytic generalisation, which is the logic behind if findings from a case study can be extended to areas outside the original research, based on the relevance of similar principles or theory [Yin, 2014, Bryman and Bell, 2015]. Table 1 suggests the tactics used in the research design to increase external validity [Yin, 2014].

*Construct validity* means to identify correct operational measures for the studied concepts. Criticism towards case studies usually points to the tendency of researchers to collect data that confirms the researchers preconceived notions, so-called "subjective judgements". The suggested tactics from table 1 mean to minimise the risk of subjective judgements and increase the construct validity when performing case studies [Yin, 2014].

*Reliability* has the objective to make sure that if the same case would be reinitiated by another researcher following the same procedures described in the original research, they should end up with the same findings and conclusions. Therefore, the goal of reliability is to minimise the biases and errors in a study. The key to increasing reliability lies in documentation and can be dealt with case study protocols as well as developing case study databases, as shown in table 1, to remove any suspicion from external reviewers concerning the reliability of the case study method [Yin, 2014]. In qualitative research it is hard to replicate since it is impossible to freeze a social environment but to counteract this the researcher should have a similar social role as the previous one to reduce bias and be able to compare the studies [Bryman and Bell, 2015].

*Internal validity* mostly concerns explanatory case studies. The first threat to the internal validity is evident when causal relationships between two events are concluded too quickly, without considering some third event that also had an impact on the result [Yin, 2014]. In qualitative research, it means there needs to be developed agreement between the observations of the case study compared to the theoretical ideas [Bryman and Bell, 2015]. The second threat concerns the problem of making inferences through previous documentary evidence without questioning its reliability with questions like "Is the inference correct? Have all rival explanations and possibilities been considered? Is the evidence convergent? Does it appear to be airtight?" [Yin, 2014]. By anticipating these questions, the overall problem of making inferences are being dealt with and therefore also the problem with internal validity. The suggested tactics to increase validity are shown in table 1 and are all part of the data analysis phase in the case study [Yin, 2014].

To deal with these areas of validity and reliability, the case study tactics from table 1 will be used. Construct validity is dealt with through multiple sources of

evidence, both in the literature review as well as data collection from interviews, since stakeholder contacts provided both inside and outside the company will be used. Concerns on internal validity will be acknowledged when reviewing and analysing literature and qualitative information to directly deal with the concerns on internal validity. Findings on areas close to the research will be studied with caution to deal with the issue of analytic generalisation and the research is designed as a mix of a single-case study with the case company as the primary focus, and a multiple-case study since different business actors will be interviewed and replication logic will be used to find evidence for general drivers and barriers as well as finding the gaps within the industry studied. Lastly, to ensure reliability, data collection through interviews can be repeated with the use of the same interview guides seen in *Appendix B, C and D*. The provided theory can also be traced back to its original sources with references being provided in the *References* section of this thesis.





## 3 Theory

*In this chapter theories relevant to the literature review is presented. The principles of circular economy and the 9R framework are mentioned first. Then circular logistics with presented frameworks for circular supply chains, the marketing mix for circular logistics as well as reverse logistics are discussed. Initiatives towards sustainable construction are later brought up, highlighting topics such as the Construction Product Regulation and CE-marking. Typical certification systems in Sweden are then mentioned and lastly, management and behaviour are discussed.*

### 3.1 Circular economy

#### 3.1.1 The three principles of circular economy

The concept of circular economy can be divided into three principles, underpinned by a transition to renewable energy [Ellen MacArthur Foundation, 2023a]:

1. *Eliminate waste and pollution*
2. *Circulate products and materials*
3. *Regenerate nature*

The first mentioned topic discusses the impact product design has in circular economy. Both the problem and solution are said to start with the product design and the author explains that "although it sometimes seems like waste is inevitable in certain situations, waste is actually the result of design choices. There is no waste in nature, it is a concept we have introduced" [Ellen MacArthur Foundation, 2023c]. The reason for this is that products are designed without considering what happens to the product at its end-of-life (EoL) phase. By designing for reuse, the material loop can start to close and this is considered the first step in implementing a circular economy [Ellen MacArthur Foundation, 2023c].

The second principle discusses how intrinsic values can be kept through

circulation of products and materials. Figure 4 shows how circulation of products and materials can be seen through both the biological cycle and the technical cycle [Ellen MacArthur Foundation, 2023b]. The model has been considered one the most popular and comprehensive frameworks on circular economy and includes several principles used in circular economy from research [Nobre and Tavares, 2021].

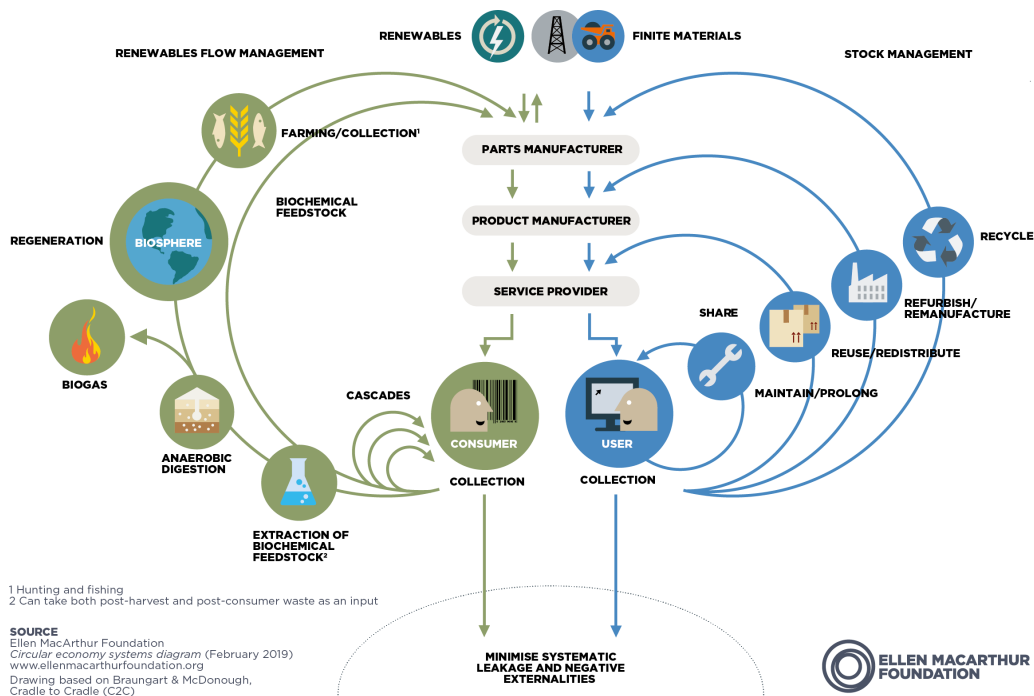


Figure 4: The butterfly diagram [Ellen MacArthur Foundation, 2019]

In the biological cycle, materials are returned to the earth through processes like anaerobic digestion or composting. This cycle concerns biodegradable products and materials that can not be processed in the technical cycle via e.g. reuse. Usage of strategies in the biological cycle help regenerate the lands to grow more food and renewable materials, like wood and cotton. For the case of renewable materials, they can usually be cycled into both the biological cycle as well as the technical cycle. Wooden furniture or cotton clothes, for example, can both

be maintained or reused and eventually be returned to the biological cycle from where they originated [Ellen MacArthur Foundation, 2023b].

The technical cycle can include renewable products as mentioned, but the cycle can also include materials that are not biodegradable. The first step for retaining value in the technical cycle is done through sharing, which can be enabled by e.g. reuse through resale or cycles of maintenance, repair and refurbishment. When a product is no longer reusable its components can be remanufactured and parts that can not be remanufactured should be recycled as a last resort. The final step is vital to allow material to be cycled back into the economy and not end up as waste [Ellen MacArthur Foundation, 2023b].

The third and final principle describes how moving from a linear economy to a circular economy will regenerate nature since this means moving the focus from extraction to regeneration. By prolonging the amount of time a product or material is used, less sourcing of virgin raw material will occur and more land can be returned to nature. Rather than extracting finite resources, the focus should be on renewable resources which will increasingly remain in circulation. It is underpinned by production using infrastructure designed for reuse, repair, remanufacturing and recycling [Ellen MacArthur Foundation, 2023d].

### **3.1.2 The 9R framework**

The terms used in the technical cycle in the butterfly diagram seen in figure 4 can also be seen in the 9R-model, which is a model used in circular economy as well [Kirchherr et al., 2017]. The model can be viewed as the "how-to" core principle of circular economy [Potting et al., 2017].

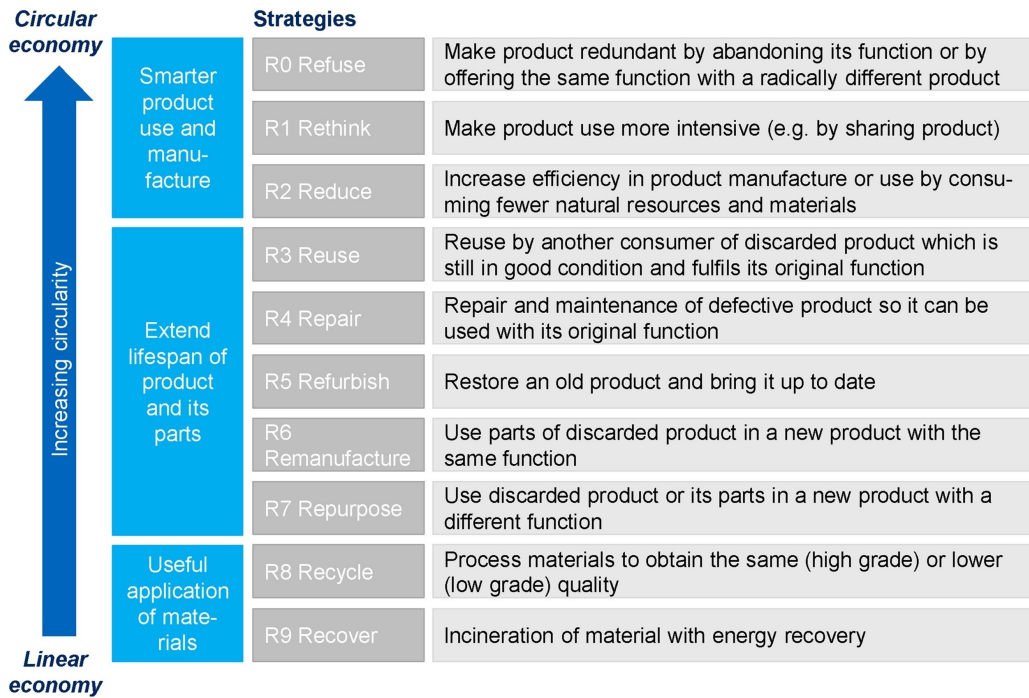


Figure 5: The 9R framework [Kirchherr et al., 2017]

In figure 5, *R0*, i.e. refuse, should be seen as a priority to the second *R*, which is rethink, and so on. This means *R3*, i.e. reuse, is the fourth priority in increasing circularity and the first priority when it comes to extending the lifespan of products and parts. Reuse is grouped together with repair, refurbish, remanufacture and repurpose since they all relate to the principle of extending the lifespan of products and their parts. The priority list also makes it clear that recovering energy, i.e. *R9*, is the final option for extracting value from resources [Kirchherr et al., 2017, Van Buren et al., 2016]

## 3.2 Circular logistics

### 3.2.1 Circular supply chains

A linear supply chain can be described by the processes *plan*, *source*, *make*, *deliver*, *return* and *enable*. *Plan* is the process of planning and controlling activities, *source* is the selection of suppliers and purchases, *make* is the production of the product from materials, *deliver* is the delivering of orders to customers, *return* is the handling of reverse flowing goods from the end user and *enable* is the design of products and processes. To describe a circular supply chain, two additional processes are added. These are *use*, describing the use, maintenance and repair of the products, as well as *recover* which is the process of reusing, reconditioning, remanufacturing and recycling of the products [Kossila, 2022]. This can be seen in figure 6.

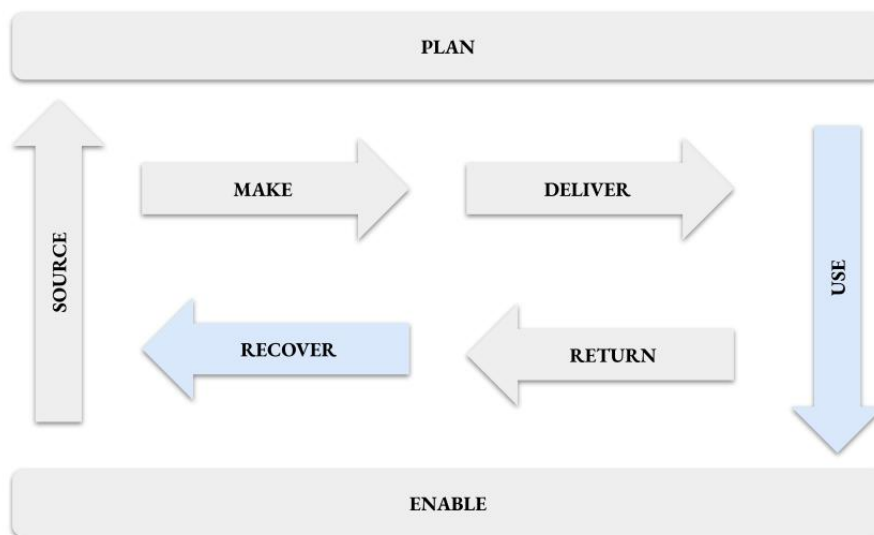


Figure 6: Circular business model processes, adapted from [Kossila, 2022]

Related to these processes are activities based on different circular strategies. New activities could be needed for a circular model, compared to a linear one.

These encompass both the old and the new processes seen in figure 6. An example of this is the strategy to recover and sell used products or remanufacture these since this would involve the processes return, recover, make and deliver with the activities of supply, remanufacture and delivery of reused products [Kossila, 2022].

The actor handling a product after it has been used can be referred to as the *gap exploiter*. In figure 7 it can be seen how a gap exploiter uses the activities refurbish, repair and remanufacture to extend the lifespan of a product. This creates a loop at the user stage where value can be retained [Kossila, 2022].

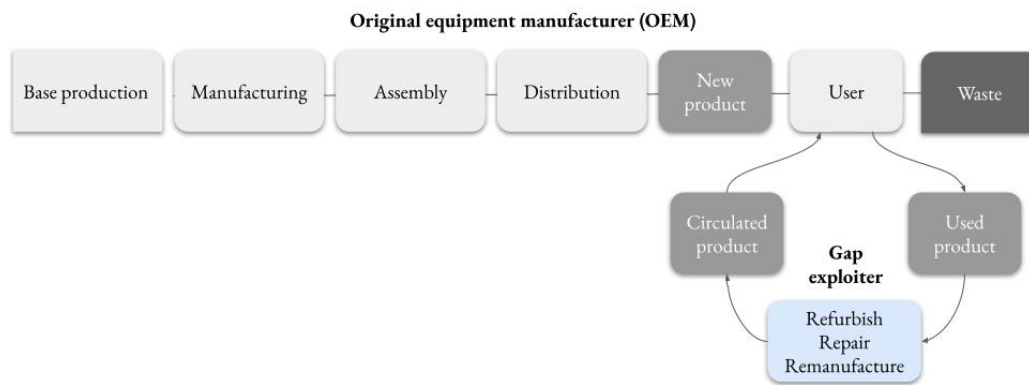


Figure 7: The gap exploiter, adapted from [Kossila, 2022]

To exploit this gap and retain value, the loops need to be organised. There are four archetypes of circular models to organise loops [Kossila, 2022]:

- *Flow management*, when a company manages the flow of items to be shared and reused.
- *Reverse logistics (RL)*, which is about creating closed loops to collect used

items so they can be reused, remanufactured or recycled.

- *Separating and sorting services*, which involves collecting waste material and sorting these to recycle into new material.
- *Recycling services*, when the company make it feasible to recycle products so it is possible to use the material again.

The flow management model and the RL model are about retaining the value by managing the product and keeping it alive for as long as possible [Kossila, 2022].

To create a longer lifespan for products, they need to be designed for circularity and the loops have to slow down. Circular design strategies are used to achieve this and the strategies are the following [Kossila, 2022]:

- *Design for attachment and trust*, the user likes the product and maintains it for as long as they can.
- *Design for reliability and durability*, the product functions for a long time.
- *Design for ease of maintenance and repair*, it is possible to repair the product easily.
- *Design for upgradability and adaptability*, the user can upgrade the product when the user's needs change.
- *Design for standardisation and compatibility*, the product is standardised and can be used with other products.
- *Design for disassembly and reassembly*, at the products EoL, it can be remanufactured and used again.

### **3.2.2 The marketing mix for circular logistics**

For companies with products following a circular design there is a need for positioning on the market in relation to other products. Traditionally, there are four tools for marketing and this is called the marketing mix or the 4 Ps: *Product*, *Price*, *Place* and *Promotion/PR*. The product and its packaging, its price and the place it can be bought give information about the offer and most marketing

decisions lead to requirements on supply chain management. For example, an expensive product with high quality sold by specialised retailers requires a different kind of supply chain than a high volume, cheap product sold on low-price markets. Promotion includes advertising campaigns with a need for an extraordinary stock of products and therefore also has an impact on the supply chain [Kossila, 2022].

As circular design of products may involve sustainable production of raw materials, spare parts availability or the ability to recycle end-used products, it implies that two new tools can be added to the marketing mix: *Pre-product* and *Post-use*, which can be seen in figure 8 [Kossila, 2022].

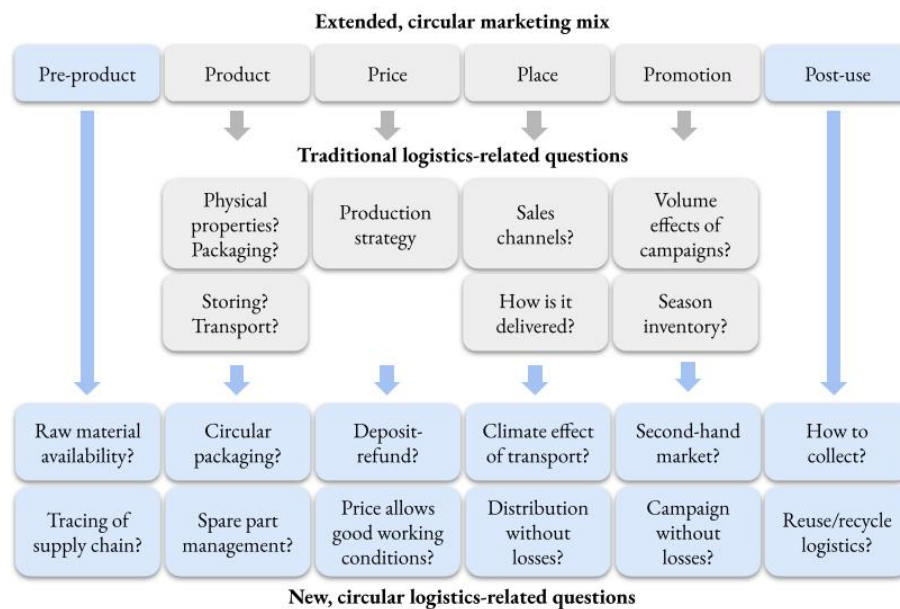


Figure 8: The circular marketing mix, adapted from [Kossila, 2022]

Pre-products refer to the raw materials, production methods and transports before the product has been handled, while post-use highlights questions about what to do with the end-used product with opportunities for reuse/recycling logistics. These two added tools have an implication on the traditional logistics-related



questions as well, since when a company decides to go embark on circular design methods and principles, questions regarding e.g. circular packaging - related to the Product - and second hand markets - related to Promotion - arise [Kossila, 2022].

*Order qualifiers* and *order winners* are also two traditional aspects used in marketing when choosing between different products on the market. Order qualifiers are products that have been selected and assumed to fulfil specific requirements, which in circular logistics could be the use of renewable materials in production, the possibility to repair a product or the availability of spare parts. The product which then finally will be purchased is called the order winner. The order winner is selected through what the consumer perceives as the most important factor. It could be the lowest price which results in a product becoming an order winner, but it could also be the most circular product becoming an order winner. Therefore it is important for a company to know what the most important order qualifiers and order winners are when customers are choosing between products since this knowledge is helpful when deciding how the supply chain should be managed. If an order winner is e.g. short delivery time, the company may have to keep stock of products, and if the ability to return used products is an order winner, a collection system is needed in the supply chain [Kossila, 2022].

### **3.2.3 Reverse logistics**

To enable circular economy and to close the loop, the reverse flow of materials, as in RL, needs to be implemented together with the main flow of materials, as in forward logistics (FL) [Ding et al., 2023, Mallick et al., 2023, Wilson and Goffnett, 2022]. This since both FL and RL should be connected in a holistic system instead of being a segregated operation in the optimal situation [Ding et al., 2023]. Holistically, RL is the process and capabilities to effectively manage products flowing in the reverse direction for any reason [Chen and Cotter, 2021].

Compared to FL, the RL flow of products is reactive and harder to track and forecast since the visibility is lower. RL is also in most cases initiated as a response to customers' actions, behaviour and will. The cost of RL is less directly visible, the quality of products is not uniform, the product life cycle is more

complex and the transportation is of the *many-to-one* type, i.e. one actor receiving products from several different units. To handle this, companies have dedicated return centres together with effective RL management and utilise centralised resources and expertise, therefore strengthening their RL volume [Chen and Cotter, 2021].

RL decisions can be split up into three levels where different decisions are made [Wilson and Goffnett, 2022]. At the strategic level, managerial considerations are brought up that are in holistic character and concern the company as a whole. On the strategic level, RL goals and strategy are also set and tracked. To increase the visibility of the goals, key performance indicators (KPI) are used [Mallick et al., 2023, Wilson and Goffnett, 2022]. The KPI:s should cover the five following aspects: financial, environmental, social, operational and management [Mallick et al., 2023].

At the second level, tactical decisions involve product design, return policies and outsourcing of RL tasks [Wilson and Goffnett, 2022]. The product design includes materials selection, composition, and dimensions [Wilson and Goffnett, 2022, Mallick et al., 2023]. A product design strategy for EoL management such as design for disassembly and life-cycle analysis are also tactical decisions to be made at this level [Wilson and Goffnett, 2022]. Another thing that needs to be kept in mind is the use pattern of the product, the contamination of it during usage as well as transportation and warehousing of it and the need for the product in the main market [Mallick et al., 2023]. Outsourcing of RL tasks is the decisions made regarding the internal capability of the company or if a third-party logistics provider should be partnered with to gain a competitive advantage. For warehousing, the decisions include various factors such as size, the layout of existing warehouses, technology, equipment, labour and the cost of returned inventory, and these are also prone to be outsourced if needed. Return policies are tactical decisions that need to be made early on during implementation to facilitate the closed-loop supply chain and incentivise customers to return the products. The incentives to return EoL products can be economic based incentives such as partial buy-backs or shipping and handling cost being covered [Wilson and Goffnett, 2022].

At the third and last level, the operational level, there are three typical activities to

recapture the value of returns when a product is at its EoL. These are collection, warehousing and reprocessing [Wilson and Goffnett, 2022]. To incentivise the return of products credits or rewards need to be given out to the returnee after the product has been returned [Mallick et al., 2023]. Firstly however a return request has to be made [Chen and Cotter, 2021] which leads to a collection where the product is screened to check the product's quality since the usage, deconstruction and freight of it could lead to damages [Wilson and Goffnett, 2022]. To also increase returns and create a pro-RL behaviour an increase in convenience such as shorter distance to the collection centres or increased service level could be used. Another thing to operationally do is to provide information to the consumer on how other users and customers use the return service to create a social environment that incentivises returns [Mallick et al., 2023]. The collection will depend on the strategy used, but there is always a need for availability of infrastructure for the collecting and warehousing [Wilson and Goffnett, 2022, Mallick et al., 2023]. Therefore a warehouse will be needed to be in place to receive, unload, inspect, sort, store and prepare for remanufacturing or reprocessing in RL. The last operational stage in an RL program is reprocessing or remanufacturing of the product. This includes repairs, refurbishments, recycling or disposals before entering secondary markets if possible [Wilson and Goffnett, 2022].

Another way to view the RL concept is to integrate key decisions over the supply chain and create a process view as a framework. A process refers to a structured and measured set of activities with a specified outcome for customers and a framework for RL can be seen in figure 9. As can be seen, the strategic processes establish a structure for the implementation of RL and are connected to the operational processes since this is the realisation of the strategic decisions [Chen and Cotter, 2021].

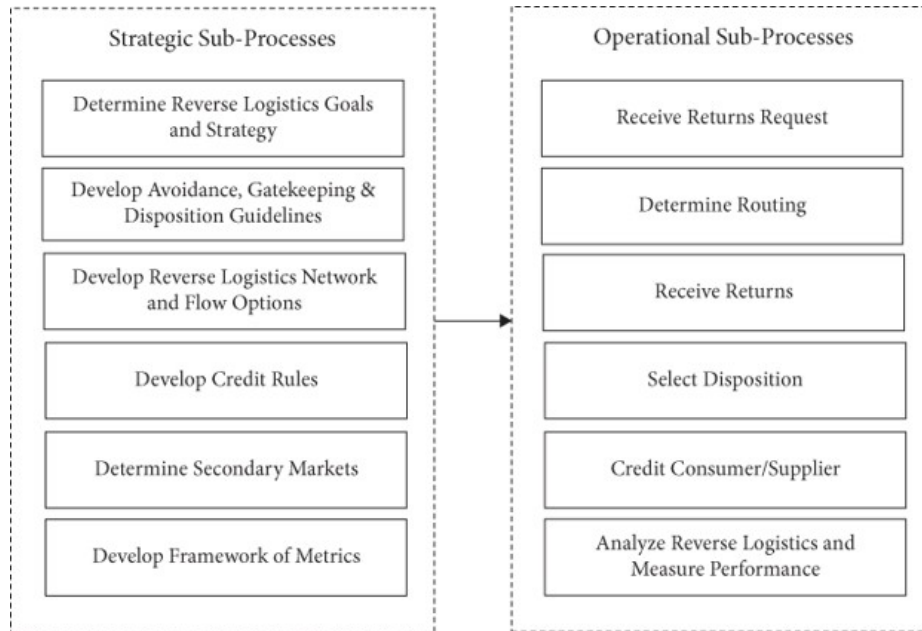


Figure 9: RL processes [Chen and Cotter, 2021]

The first step of the strategic processes is to *determine the RL goals and strategy*. These decisions include RL strategies and capabilities to improve customer loyalty, increase profitability, capture value, recover assets, adjust product offerings and follow regulations and laws [Chen and Cotter, 2021].

*Develop avoidance, gatekeeping and disposition guidelines* is the second strategic process where working with suppliers and customers has to be done to effectively use avoidance, gatekeeping and disposition to minimise the cost of moving products in the reverse flow. The aim of avoidance is to reduce the number of return requests due to faulty products while gatekeeping's goal is to identify what products should be accepted into the RL flow. The disposition enables fast routing of the product to the appropriate place and this can include secondary markets, recycling, reprocessing or landfill [Chen and Cotter, 2021].

In the step to *develop RL network and flow options*, decisions made regarding the transportation modes and methodologies in RL are made if the FL network or a

stand-alone RL network should be used or if the activities should be outsourced or not [Chen and Cotter, 2021].

The next step in the process is to *develop credit rules* based on the feedback from suppliers and customers. Authorisation guidelines and policies regarding credits and procedures on how this should be handled are made during this process [Chen and Cotter, 2021].

*Determine secondary markets* needs to be done and companies have to decide what secondary market channels are best suited for the RL flow. These market channels could be online auctions, value retailers or outlets. The decisions made have a goal to maximise value capturing while not cannibalising the sales of virgin products [Chen and Cotter, 2021].

Lastly, for the strategic processes, a *framework of metrics have to be developed* to track the efficiency and effectiveness of the company's operational performance. The metrics should trace and analyse return rates, the cause of the returns and the financial impacts of RL activities on revenue, cost, assets and profitability [Chen and Cotter, 2021].

The operational processes start with *receiving return requests* where the implementation of the gatekeeping guidelines is created. *The routing is then determined* and the company reviews routing guidelines, plans the routing and generates return material authorisations. The next process is then to *receive the returned products and materials*. The products are then verified and inspected. The return is also processed and the return reason is clarified [Chen and Cotter, 2021].

The company then *selects the disposition* guidelines and transports the product to its final disposition. *Credit authorisation* across the supply chain and a negotiated settlement is made with customers or suppliers and is coordinated by the company. Lastly, the company *analyses the returns* and identifies opportunities. The economic value is calculated and goals are set for the performance [Chen and Cotter, 2021].

The important step to reacquire products and materials is another operational process. The archetypes to receive the items back are the following [Mallick

et al., 2023]:

- Consumer drop-off
- Door-to-door pick-up
- Informal sector-based
- Internet-based solutions
- Mail-Back
- Hybrid models

The acquisition archetypes affect costs, consumer convenience and collection capacities, and there are different criteria for what archetype to choose. The first criteria is *product characteristics* where the aspects are product dimensions and use-pattern of the products. The second one is *strategic factors* and includes the aspects of convenience, traceability for the producer, hybridity for collection and flexibility and responsiveness. *Economic factors* is the third criteria and the aspects are cost, profitability and incentives while *operational factors* are the next with aspects such as operating time, handling system capacity and human resources. The last three criteria are *environmental factors*, *social factors* and *business risks*. The aspects are emissions during collections and compliance with regulations for environmental factors. For the social factors, stakeholders' willingness to participate, transparency for consumers, staff requirements, health and safety are highlighted. Lastly illegal imports, supply risks and insufficient collection and risk of change in regulations are the aspects of the business risks criteria [Mallick et al., 2023].

### **3.3 Initiatives towards sustainable construction**

#### **3.3.1 Construction products regulation**

As mentioned in chapter 1.1.1, the circular economy action plan highlights the CPR as part of efforts towards a more energy- and resource-efficient construction industry.

The objective of the CPR is to ensure that construction products can circulate freely within the European single market. To meet this objective, the CPR presents harmonised rules for construction products to be put on the European market. The already existing rules focus on how the performance of construction products can be expressed in relation to their main characteristics. This could include how construction products e.g. react to fire, conduct heat or insulate sound. Harmonised rules for CE-marking of the concerned products are also included in the CPR. These rules ensure that reliable information is available to consumers, public authorities as well as professionals, and makes it possible to compare the performance of products from different manufacturers in different countries [European Commission, 2022].

The CPR is currently being revised, for the reason that it is assumed to no longer fit to meet broader policy priorities, especially on the European Green Deal [European Commission, 2022], the initiative towards a carbon-neutral Europe [European Commission, 2023b].

The aim of the new, revised, CPR is to [European Commission, 2022]:

- Ensure free movement of construction products and a smooth functioning of the European Single Market.
- Address performances related to sustainability of construction products.
- Contribution in meeting climate and sustainability goals through a better construction ecosystem as well as embracing the digital transformation.
- Make sure harmonised standards contribute to the competitiveness of the ecosystem and reduce barriers found in the market.

The revised CPR will also intervene to set sustainability criteria for construction products through the Ecodesign for Sustainable Products Regulation. The Ecodesign regulation aims to make sustainable products the norm in the EU and reduce their environmental footprint throughout the entire value chain. This initiative proposes that the *take-make-use-dispose* model can be avoided and that much of a product's environmental impact can be determined at the design phase of a product. There is also a strategic benefit to this initiative, since the resource independence in the EU can become stronger and economic opportunities for

innovation can be created, especially regarding remanufacturing, recycling and repairs [European Commission, 2022].

The proposal of the new CPR also includes that manufacturers will have to present environmental information about the life cycle of their products and comply with the following obligations [European Commission, 2022]:

- Products and their packaging should be designed and manufactured in a way that overall environmental sustainability meets state-of-the-art level.
- Give preference to both recyclable materials as well as materials produced out of recycled materials.
- Adhere to minimum recycled content obligations and other limit values regarding environmental sustainability.
- Make sure instructions for use and repair is available in product databases.
- In product design - reuse, remanufacturing and recycling should be facilitated.

This new revision of the CPR will minimise compliance costs through an improved standardisation process, provide clearer provisions, reduce national requirements and also promote the reuse of products [European Commission, 2022].

### **3.3.2 CE-marking for construction products**

The advantage of CE-marking for construction products is all countries in the EU must approve sales of CE-marked construction products. This means no local governments can demand excessive quality markings, certificates or more comprehensive testing. This also means the same CE-documentation can be used within all of the EU and it also helps end-consumers to verify the performance of the product and compare it to other CE-marked products. A CE-marking contains essential information about the product and is a guarantee of its performance. A CE-marking is compulsory for most construction products and these follow the European Committee for Standardisation route for CE-marking [European



Commission, 2015].

Along with the proposal of a revised CPR, the possibility to CE-mark reused construction products is also a topic being discussed, based on that the reused construction product fulfils the same requirements as the virgin product [Regeringskansliet, 2022].

### **3.3.3 Boverket**

Boverket is the Swedish National Board of housing, building & planning, and is a governing authority [Boverket, 2023a]. They collaborate on a Nordic, European and international level and the Swedish Building Regulations must not contradict the EU Internal Market by the European Commission. According to instructions, Boverket shall support the Swedish EU-collaboration. The Nordic collaboration also means Boverket is included in the Nordic party, by means of collaborating on questions regarding digitalisation, climate declarations as well as the revision of the CPR [Boverket, 2023b].

### **3.3.4 Environmental product declaration**

Products can also be compared environmentally through Environmental Product Declarations (EPD). An EPD transparently shows objective and comparable information about a product's or a service's environmental performance and is always verified by a third-party. The foundation of an EPD lies in its life cycle assessment to enable evaluation of a product's environmental performance over its entire life cycle. This also includes a product's EoL phase. An EPD is also compliant with the international standard and they are created and registered in the framework of a programme where the registrations are publicly accessible [EPD International, 2023].

### **3.3.5 Other initiatives towards sustainable construction**

Due to economic crimes and illegal workforce in the construction business, Danske Bank, Handelsbanken, Nordea, SBAB, SEB and Swedbank have come together in Sweden to actively work against illegal activities in the construction industry, as part of their social responsibility work. This initiative means the banks are setting higher requirements for their financing of construction projects, such as digital reporting and that projects have pre-announced contractors that will be involved [SBAB, 2021].

Banks such as Swedbank also focus on concepts like green construction credit, meaning financing of projects following Green Building Certifications (GBC:s) [Swedbank, 2021]. Green loans set green bonds to the borrower, making sure the money is used in relation to positive environmental impact. The green bonds may also come with tax incentives to investors to enhance the attractiveness [Segal, 2022]. This also lets investors contribute to a more green society [Swedbank, 2021].

## **3.4 Certifications**

### **3.4.1 Certification systems in Sweden**

There are several environmental certification systems used for buildings and infrastructure in Sweden. The six most common environmental certification systems in Sweden are [Boverket, 2023c]:

- LEED
- Miljöbyggnad
- BREEAM-SE
- City Lab Action Certification
- GreenBuilding
- Swan Ecolabel

Among these six systems, LEED, Miljöbyggnad and BREEAM-SE are GBC:s which have indications of circular material flows. Some of the listed items above are used on a global scale, e.g. LEED, while some are used on a national or Nordic level, such as Swan Ecolabel and Miljöbyggnad. The systems have different focuses and are used to certify different types of projects in the construction industry [Boverket, 2023c].

Certification systems are also a way for a producer to show that products have been designed and produced according to circular or sustainable strategies [Kossila, 2022].

The following three chapters will go more in-depth on LEED, Miljöbyggnad and BREEAM SE, being some of the most practised GBC:s in Sweden [Swedish Green Building Council, 2023b], while also having implications on reuse of construction materials.

### **3.4.2 LEED**

LEED is an international certification system that was founded in 1998 to deal with international markets, e.g. Sweden, and increase environmental understandings [Swedish Green Building Council, 2023c]. The system is built upon receiving credits in different categories that can be seen in figure 10 [LEED, 2023b].



Figure 10: LEED credit categories, adapted from [LEED, 2023b]

A project can receive a level of certification by adjusting to prerequisites and earn credits that address energy, carbon, waste, water, transportation, materials, health and indoor environment. Depending on how many credits a project receives, the project can receive either a *Platinum*, *Gold*, *Silver* or *Certified* level of certification, with *Platinum* being the highest level of certification, and *Certified* the lowest. The goal of LEED is to create better buildings that for example ”promote sustainable and regenerative material cycles” and 10 per cent of the total amount of credits relate to the green economy [LEED, 2023a].

### 3.4.3 Miljöbyggnad

Miljöbyggnad is a Swedish certification system and it is also the biggest GBC in Sweden [Swedish Green Building Council, 2023b]. Miljöbyggnad uses 15 indicators to determine what level of certification a building can achieve. All indicators refer to any of the United Nations Sustainable Development Goals [United Nations, 2023]. Among these 15 indicators, circular material flows is included as number 13, with the purpose of promoting reuse and construction

materials containing recycled parts. This indicator contributes to the third sustainable development goal of good health and well-being, as well as the 12th goal of responsible consumption and production [Sweden Green Building Council, 2022].

These indicators in Miljöbyggnad’s certification process can all be graded as either *Bronze*, *Silver* or *Gold* level where the criteria from a previous level need to be fulfilled as a prerequisite to reaching a higher level. The rating criteria for indicator 13 can be seen in figure 11 [Sweden Green Building Council, 2022].

	BRONZE ●	SILVER ●	GOLD ●
Accommodations and facilities	<ul style="list-style-type: none"> <li>At least two construction products should contain at least 10 weight percent recycled material.</li> </ul>	<ul style="list-style-type: none"> <li>Grade Bronze is fulfilled.</li> <li>At least two construction products should contain at least 20 weight percent recycled material.</li> </ul> <p><i>Or</i></p> <ul style="list-style-type: none"> <li>Grade Bronze is achieved.</li> <li>At least 20 weight percent of at least one construction product should be reused material.</li> </ul>	<ul style="list-style-type: none"> <li>Grade Silver is fulfilled.</li> <li>At least 20 weight percent of at least two types of construction products should be reused material.</li> </ul> <p><i>Or</i></p> <ul style="list-style-type: none"> <li>Grade Silver is achieved.</li> <li>At least 40 weight percent of at least one product group should be reused material.</li> </ul>

Figure 11: Example of rating criteria [Sweden Green Building Council, 2022]

To receive a specific certification level, the specific rating criteria for all 15 indicators need to be fulfilled, regardless of what type of project the certification is aimed at [Sweden Green Building Council, 2022].

#### 3.4.4 BREEAM-SE

With BREEAM-SE it is possible to certify a building according to Swedish rules and standards, while also receiving a certification that is comparable internationally [Swedish Green Building Council, 2023a]. The aim of BREEAM is to e.g. mitigate the life cycle impacts of buildings on the environment, and enable buildings to be recognised according to their environmental benefits. The objective of BREEAM is also to create market recognition of buildings with a low environmental impact [SGBC & BRE Global, 2023].

The BREEAM-SE certification system is built upon credits for 10 different categories. The category *Materials* focuses on e.g. hazardous substances, where the aim is to encourage use of products that contain none or low levels of hazardous substances, as well as simplifying future reuse of products and materials in the building. The *Waste* category focuses on e.g. construction waste management, where credits can be awarded for reusing materials on site or in other applications, as well as salvaging or reclaiming materials for reuse [SGBC & BRE Global, 2023].

The rating system BREEAM-SE uses is based upon credits and weighting to calculate a total score, which then can be translated into six levels of certification, which can be seen in figure 12

BREEAM-SE Rating	% score
OUTSTANDING	≥ 85
EXCELLENT	≥ 70
VERY GOOD	≥ 55
GOOD	≥ 45
PASS	≥ 30
UNCLASSIFIED	< 30

Figure 12: BREEAM-SE certification levels [SGBC & BRE Global, 2023]

An "outstanding" rating is the highest level of BREEAM-SE certification a building can receive, while an "unclassified" BREEAM-SE rating represents a failed certification. Each credit category has a different amount of total credits that can be achieved, and the total score per category is based upon the percentage of credits received in the category, multiplied by the fully fitted weighting of that category. An example score and rating calculation can be seen in figure 13 [SGBC & BRE Global, 2023].

BREEAM-SE section	Credits achieved	Credits available	% of Credits achieved	Section weighting (Fully fitted)	Section score
Management	10	23	43.48%	0.11	4.78%
Health and wellbeing	17	21	80.95%	0.17	13.76%
Energy	16	26	61.54%	0.18	11.08%
Transport	5	9	55.56%	0.07	3.89%
Water	5	9	55.56%	0.04	2.22%
Materials	10	13	76.92%	0.17	13.08%
Waste	3	8	37.50%	0.08	3.00%
Land use and ecology	5	10	50.00%	0.10	5.00%
Pollution	5	12	41.67%	0.08	3.33%
Innovation	2	10	20	0.10	2.00%
Final BREEAM-SE score					62.14%
BREEAM-SE Rating				VERY GOOD	

Figure 13: BREEAM-SE score and rating example [SGBC & BRE Global, 2023]

As can be seen in figure 13, the *Materials* section has one of the highest fully fitted weights, which is the section including aspects of reuse.

### 3.5 Management & behaviour

In figure 14 the framework for the four dimensions of management is presented. The framework contains means and ends and eight management principles. The eight principles are *bureaucracy*, *emergence*, *hierarchy*, *collective wisdom*, *alignment*, *obliquity*, *extrinsic motivation* and *intrinsic motivation* [Birkinshaw, 2012].

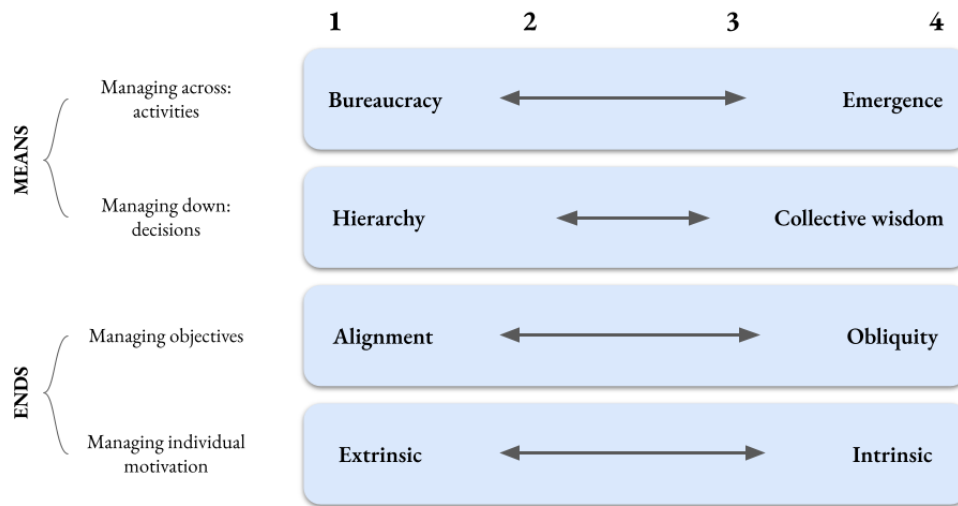


Figure 14: The four dimensions of management, adapted from [Birkinshaw, 2012]

Bureaucracy is the means of coordinating economic activity with formal rules and procedures while emergence is spontaneous coordination achieved through the interests of independent actors. Hierarchy structures work to provide managers with legitimate authority since the managers have the experience and wisdom to do so. Collective wisdom suggests a large number of people could produce better results than a small number of experts. Alignment in a business context mean all employees work directly towards the goal while oblique mean work towards goals indirectly. Extrinsic motivation is motivations from outside the person such as money and intrinsic motivation is the rewards inherent to a task or activity [Birkinshaw, 2012].

To further explain the principle hierarchy of collective wisdom, it can be split into four tasks, communicating with subordinates, gaining input from subordinates, solving problems and innovating with the help of subordinates and making use of external input to improve decision-making. To increase innovation and improve decision-making as a whole, all aforementioned tasks need to be considered and used. Important to note is how the crowd is good at answering focused problems,



but bad at open-ended discussions. They might not have the skill or will to make decisions and could head towards the wrong direction of the goals set as well. Since this is the case, complete collective wisdom can also be a weakness and the importance of choosing the appropriate task is highlighted [Birkinshaw, 2012].

Managing individual motivation to shape the behaviour of subordinates is based on two theories, *theory X* and *theory Y*. Theory X is the theory "workers are lazy" and need extrinsic rewards to get work done, while theory Y is the theory "workers are self motivated, ambitious and intrinsically motivated". The motivation spectrum in figure 15 shows three different drivers of motivations [Birkinshaw, 2012].

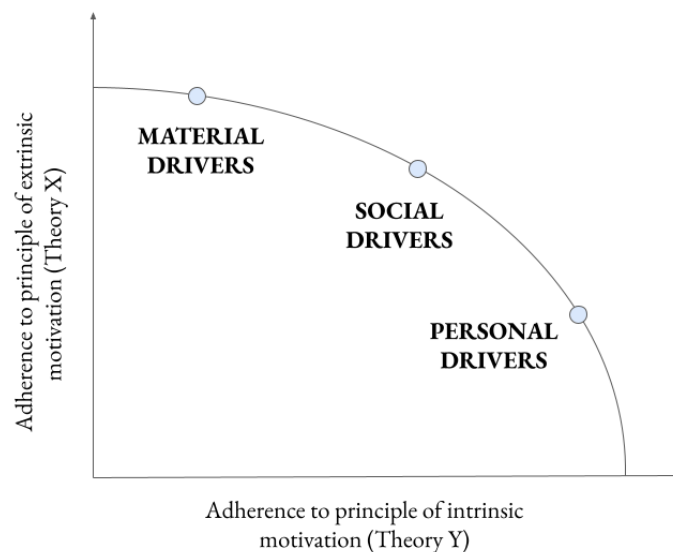


Figure 15: The motivation spectrum, adapted from [Birkinshaw, 2012]

*Material drivers* are drivers related to direct rewards [Birkinshaw, 2012]. These rewards could be cash incentives, discounts when purchasing products or tax benefits which encourage a certain behaviour [Mallick et al., 2023]. *Social drivers* include the motivation from being a part of a group or community [Birkinshaw, 2012]. Spreading information and awareness to others in the social group is a part of something that could have an impact in a social environment

as well as the social norm, creating the wished behaviour [Mallick et al., 2023]. *Personal drivers* are based more on intrinsic motivation and personal satisfaction from doing the work [Birkinshaw, 2012]. Personal attitude and values also have an impact if action is taken as well as the intention of the individual [Mallick et al., 2023], which relates to personal drivers. A combination of all three drivers is needed to achieve the best result to motivate and make the most of the individual stakeholders [Birkinshaw, 2012].

To manage change and behaviour, change agents can be used. Five themes should be in place for a change agent to operate optimally. The first theme is finding the degree of freedom available and use this to the fullest. The second is to build a team or group of allies who support the process and creates legitimacy. The third is to take an experimental approach which is trying the idea in a low-risk, self-contained setting. The fourth theme is to give the project a name to build interest and something specific for people to remember. The last theme is to seek out support from above since a change can not be made long-lasting without the support of upper management or the people with the most influence [Birkinshaw, 2012].

Smarter choices and innovation can be made through four key steps for a management model. This framework is presented in figure 16, where the steps are *understanding, evaluating, envisioning* and *experimenting* [Birkinshaw, 2012].

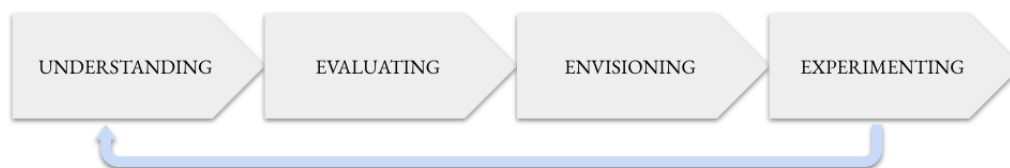


Figure 16: Innovate your management model, adapted from [Birkinshaw, 2012]

*Understanding* is the step and need to understand the challenge ahead. It is crucial to be aware of the choices made using the framework. *Evaluating* is the need to assess what principles are suitable for the business environment as well as finding the blockers preventing change. *Envisioning* means the step to identify new ways of working. This is done after the problem has been narrowed down and a solution is to be found. The last step, *experimenting*, is the step to try the solution on a smaller scale and observe the outcome. This step then loops back into the first step creating an iterative framework for continuous innovation [Birkinshaw, 2012].



## **4 Empirics**

*In this chapter the empirics found through internal and external interviews will be summarised, addressing sustainability knowledge and perceptions, reuse and selective demolition practices, project influence, aspects related to reuse, drivers and barriers as well as future visions regarding reuse. The internal interviewees are summarised for both sales and marketing personnel, while the external interviewees are divided by company type. Following the detailed summaries, typical stakeholders are created to present an overview and summary of the different stakeholder categories. Lastly, best practices found through literature will also be presented.*

### **4.1 Internal interviews**

#### **4.1.1 Perception and knowledge of sustainability**

The internal interviewees' perception of sustainability was identified through what trends related to sustainability they perceived as popular in the construction industry, as well as their perception of reuse. Interviewees' theoretical knowledge of sustainability terms related to the 9R framework presented in chapter 3.1.2 was also evaluated to test if the interviewees could differentiate between different circular strategies. The interviewees' perception of provided internal courses in sustainability to find potential gaps.

All interviewees associated reuse with current popular trends related to sustainability in the construction industry, with incentives of either building more sustainably, reducing waste, reducing environmental footprints or as a manufacturer, helping the industry with reuse and recycling. Some interviewees also mentioned knowledge and interest in circular economy and sustainability is increasing and highlights the importance of interest in the subject, as an increase in interest also results in understanding and actions taken towards more sustainable construction. However, these interviewees also perceived the construction industry as being a slow moving, non-flexible industry regarding change and therefore believe the interest needs to grow even more. One of

them also mentioned building environmentally friendly five years ago was always discussed, but no one acted upon it. One interviewee stated that without knowledge and understanding of why one should build more sustainably, it will never occur. Another interviewee also mentioned EPD:s as another trend related to sustainability and another mentioned GBC:s as a trend, especially for real estate companies.

The concept of reuse is promoted by all of the interviewees, both within the sales department and the marketing department. One explained acoustic ceilings as a prime example of a product to reuse because of the technical aspects being maintained and the simplicity when deconstructing or moving it. Another meant that the product is possible to put into a circular loop, also because of the technical aspects being maintained. One interviewee said working at the forefront of the construction industry regarding sustainability is motivating and also creates credibility for the company and their product. A problem with reuse identified by one of the interviewees was “who pays for this”, pinpointing additional costs related to reuse.

In general, the internal interviewees’ knowledge of the differences between the terms reuse, recycling and refurbishment were somewhat evident. There were some disagreements on how these terms are perceived on their own, especially for the term refurbishment, which was also the term interviewees had the hardest time differentiating against reuse. One interviewee explained refurbishment as providing opportunities for other activities, while some other interviewees meant refurbishment as restoring a product to its original state. Another interviewee reasoned about refurbishment being financially sustainable or not. One of the interviewees could not explain what refurbishment was and defined recycling as regathering a product and freshening it up. Most of the interviewees could however differentiate between reuse and recycle, where two mentioned what can not be reused should be recycled. All of the interviewees could define the basic concept of reuse.

Most of the interviewees had attended an internal course on sustainability and circularity, and most of them also referred to the “block sustainability course” given at the case company. All interviewees agreed on the importance of internal sustainability courses, where one mentioned knowledge as a tool to

open up sustainability and reuse for discussion. However, another interviewee mentioned there sometimes was a knowledge gap between current base knowledge in sustainability and presented information during courses, saying it was too technical. One interviewee had not attended any internal course and another mentioned attending a sustainability course but can not recall anything about circular economy. Some interviewees also mentioned case company sustainability experts as a source of knowledge.

#### **4.1.2 The construction market**

How sustainability in the construction market is perceived today by the internal employees was discovered through questions related to customer influence on materials, perceived customer knowledge on circular economy and reuse, customer demand for reuse as well as marketing channels.

Regarding influence on the choice of materials, all interviewees mentioned installers as having a high influence on chosen material for new construction or reconstruction, since they are the case company's direct customer and the case company's extension into the market. Some interviewees also believed architects and real estate companies have an influence as well, but discussed the installer's possibility to change prescribed materials from architects and real estate companies, making their influence somewhat limited. General contractors (GC:s) are also mentioned by some interviewees, as having an influence as well, where one interviewee argues how large GC companies can influence the market on sustainability questions, regarding e.g. carbon footprint.

The demand for reuse has increased according to all of the interviewees, where some mentioned real estate companies as the driving stakeholder for reuse, whereas municipalities demand reuse e.g. construction of schools or other projects facilitated by municipalities. One interviewee meant GBC:s and building more sustainable are the main reasons behind demanding reuse while another suggests sustainability is at the heart of some companies. Some interviewees explained customers today have an ambition of building more sustainably and understand the need for it, but it is rarely acted upon due to cost issues, lack of knowledge on reuse practice as well as resistance from installers. This

resistance to reuse was explained by the interviewees to be derived from the lack of profitability, interest and increased labour costs for installers. Storage possibilities for installers were also referred to as a challenge by the interviewee.

As the demand for reuse has increased, some interviewees said the availability of reused materials is insufficient. This is also why questions regarding the availability of reused ceilings at the case company have increased from real estate companies, explained an interviewee. One of the interviewees meant real estate companies are ready to purchase any reused material they can get their hands on. Requests had also been received by one of the interviewees, where demolition companies asked to return ceiling tiles to the case company, instead of sending them to landfill, but further explained the case company had no current service for taking back material and therefore had to dismiss that type of request.

The knowledge customers have on circular economy was perceived as varied by all of the internal interviewees. Some interviewees suggested architects and real estate companies are more knowledgeable on circular economy and reuse compared to installers since architects and real estate companies are usually the ones driving sustainability. Another interviewee explained cases where companies used external sustainability experts using standards not applicable to the Swedish construction market, hence meaning the knowledge varies between companies. Two of the interviewees argued installers have low knowledge of circular economy while understanding reuse better since it is a concept closer to practice. Some interviewees disagreed on the knowledge architects and real estate companies have concerning the retained quality of acoustic ceilings sold by the case company. One suggested architects understand quality is retained for the ceilings and has good knowledge overall of acoustic ceilings, while another pushed the importance of making architects understand the properties of acoustic ceilings to better define what would count as an equivalent product in a prescription of construction material.

Appropriate marketing channels for reuse were also discussed and one interviewee suggested the usage of the same marketing channels used today for new products, but also implied the different channels are used for different purposes. All of the interviewees promoted digital marketing channels, such as the case company website and social media, and some interviewees also referred



to LinkedIn, specifically to market towards architects. One interviewee suggested marketing via environmental journals, keeping information at a low level for everyone to understand and two other interviewees argued marketing should reach out to real estate companies specifically. One interviewee also implied the importance of marketing towards all different GBC:s and include information on GBC:s in EPD:s.

#### **4.1.3 Pricing and assurances**

Questions about pricing and assurances were also discussed in the interviews to identify possible offers in the reuse market for acoustic ceilings.

Regarding price, the majority of interviewees believed reused acoustic ceilings can be sold for the same price as a virgin product, but with different reasoning. One interviewee meant a zero environmental footprint proof must be part of the reuse offer to sell the product for the same price. Two of the interviewees suggested it should be possible to sell a reused ceiling for the same price as a new one, as long as the case company can offer a warranty as well. One of these interviewees explained further that if a customer has the ambition to adopt sustainable construction, they will understand the value of a reused product. This interviewee also added it would be unwise to set a higher price for a reused ceiling than a new one since it would limit the market. Another suggested it is hard to sell a reused product from the case company for a higher price, due to the product already being perceived as a premium product. The other two internal interviewees believed either a reused acoustic ceiling could be sold for a higher, or a lower price than a virgin product. The employee promoting a higher price meant it would be possible if there is a proof of lower environmental footprint on the reused ceiling and if the quality is as good as for a virgin product. The other interviewee, suggesting a lower price, argues that reused material, in general, is viewed as cheaper than new material, thus reused acoustic ceilings need to be cheaper as well.

Assurances suggested by the interviewees were above all warranties, however, the majority of interviewees believed either warranties are not needed or are hard to provide in the offer of a reused product. These interviewees argued the

stakeholders demanding reused acoustic ceilings know the product's technical functionalities are retained. They also explained questions received from customers about reuse never concerned warranties. Another explained it is hard to give warranties due to non-existent standards for reused products. Those who promoted warranties meant warranties were needed to either assure the quality of the reused product or to prove it works as well as a new product. However, to be able to give no warranties, one interviewee argued information regarding the products' past and use would need to be provided.

#### **4.1.4 Regulations**

The interviewees' views on regulations concerning circular economy and reuse for enabling sales of reused material were also discussed during interviews.

The view interviewees had on local and European regulations were mostly related to the current cost of landfill in Sweden. They referred to landfill as a barrier to reuse, meaning it is too cheap in relation to other sustainable alternatives, such as recycling or reuse. Some interviewees also mentioned a need for a more comprehensive regulatory system and standards for reuse specifically to make regulations a driving factor for reuse, thus also suggesting a need for larger initiatives from public authorities to make fewer products end up in landfill. One of these interviewees believes regulations could have an impact on the pricing of a reused product as well and another interviewee suggests with a more comprehensive regulatory system for reuse, the gap between supply and demand would decrease. A lack of knowledge regarding regulations and the current CPR was however brought up by some interviewees, thus not wanting to share any further views on drivers and barriers originating from regulations.

#### **4.1.5 Future visions**

Finally, for the internal interviews, future visions on the construction industry regarding reuse, circular economy and sustainability trends were discussed with interviewees, as well as visions of services the case company could provide concerning reuse.

The interviewees had different ideas and future visions related to circular economy and how to make reuse a more widely adopted concept. Some interviewees recalled the need for a proper regulatory system and government initiatives towards reuse as well as other sustainability aspects like an increase in the cost, or even prohibition, of landfill, while others believed a rise in awareness of sustainability concepts and reuse could lead to increased reuse practices. Some of the interviewees also believed there needs to be incentives in place for those who are restricted towards reuse and some interviewees proposed return systems constituted by the case company to help close the loop of material flow. An interviewee discusses a vision to easily quality-check materials in relation to a return system. Availability is also an aspect brought up by an interviewee in a sense to make reused materials easily available to customers, believing customer focus is a priority. Here, interviewees also suggest an e-commerce solution for the case company with available filtering options for reuse. Several interviewees also promote the use of a pilot project to market reuse.

All of the interviewees believed sustainability aspects like reuse and circular economy in the construction industry is a trend that will continue to grow in the future and the market for reuse will increase. One interviewee meant the younger generations will grow into a more sustainable industry and companies need to adopt sustainable practices to not be deprioritised by the younger generations seeking employment. As for the future, another interviewee had a vision of sustainable construction without the need for GBC:s and one interviewee meant the cost of construction material will be more closely compared to its environmental footprint and further believed there will be requirements on environmental footprints as well as cost as a standard for future construction.

## **4.2 External interviews - planning phase**

### **4.2.1 Perception and knowledge of sustainability**

The interviewees involved in the planning phase of a project, i.e. architects, GC companies, real estate companies and project consultants, were questioned on

the topic of sustainability, circular economy and reuse. Questions asked involved current trends in the construction industry, the perception of a market for reuse, as well as sustainability training, like internal or external courses.

### **Architects**

The most recognised trends by the architects were reuse, along with circular design processes, like designing for deconstruction, recycling and building for the development of society. One of these architects believed reuse should not be seen as a trend but as a must. The other meant reuse projects that are well done received the most attention among construction projects today. These trends were mentioned by one of the interviewees to still be relevant in the future since involving products in a closed loop should be a goal to aim for. The other interviewee meant they can not stay as trends, since they are fundamental questions that need to be handled.

Both interviewees believe there is a market for reused construction materials, like e.g. roof tiles and acoustic ceiling tiles and furniture, but one meant the concept needs to become more organised, and further used an example from the furniture business, explaining a business where it is easy to be presented with reused products and therefore also easy to prescribe them. The interviewee did not believe the construction business was as developed as the previously given example. One interviewee explained acoustic ceilings as a known material and could also see an interest in reusing them, but added they are unable to do so today due to virgin material currently being cheaper than reused. The other interviewee explained that reused acoustic ceiling tiles could be appropriate for secondary rooms, like toilets and copying rooms.

One of the architects explained the differences between reuse and recycling using the value hierarchy, implying reuse retains more value than recycling. The other interviewee referred to the functional differences between reuse and recycling, saying that for reuse the product is retained at its current value, while recycling means using recycled materials to bring value to new products. The differences between reuse and refurbishment were explained through functional differences by both interviewees, however, one of the interviewees mentioned it was hard

to draw a line between the two, but meant refurbishment needed some kind of processing while reuse does not. The other interviewee explained refurbishment as a possibility for a product to become its own version 2.0.

Regarding sustainability courses and training, none of the interviewees had attended any. One of the architects explained there are specialists within the organisation having this knowledge and internal courses are given, but just had not been attended by the interviewee. The other interviewee believed sustainability courses would bring value to their organisation. Both interviewees were interested in courses that could be given by suppliers, but one wanted the belonging information to be kept at a general level, while the other wanted it to be product specific, since the company giving the course knows their own product the best and not necessarily the entire sustainability questions handled.

Both interviewees also had a positive view towards the concept of reuse, where one meant it is horrible to watch functional good-looking products be thrown away, and the other explained they had just started working with reuse and how there is plenty to work on.

### **General contracting companies**

When it comes to trends in the construction industry, identified by a business support & developer and a project manager at GC companies, reuse is mentioned by both as a current trend in sustainable construction. Other mentioned trends were biodiversity, circularity, circular economy, reducing CO2 according to laws, donating material instead of throwing, a will to do the right thing when it comes to the environment as well as sustainable company policies. Both interviewees believe these mentioned trends will still be relevant in the future, with arguments it is the future to build circularly and that the transition towards more sustainable construction is natural due to younger generations growing into a society where the focus is on sustainability.

Their opinions on if there is a market for reuse in Sweden are split, where one believes everything is possible to reuse and another argues some products and materials are more obvious to reuse than others. They both however believe there

is a market for reused acoustic ceilings in Sweden, but argued refurbishment of ceiling tiles might be necessary.

Regarding term knowledge, both interviewees explained reuse as using a product again in its current state. Recycling was explained as the decomposition of a product and using it for other purposes. Refurbishment was referred to as either upgrading a product, hence adding value to it, or repainting or freshening up a product.

Webinars were used for courses in sustainability, which were decided by one interviewee, while the other had not attended any courses on sustainability. Both would be interested in courses given by a manufacturer, however, one would like the courses to be held general to reuse and circular economy, while the other would want it to be product and project specific.

### **Real estate companies**

All the interviewees working in real estate believe reuse is currently a trend in sustainable construction. Other trends mentioned were fossil-free products and materials, circular flow, smart solutions for sustainability work, digitalisation and sustainable logistics. It was believed these trends would still be relevant in the future by all the interviewees, but some also mentioned there is a lack of materials in general, which has led to higher material costs, and there is a need for even more circular flows, cooperation, working smarter and more rules on CO2 footprint for new projects. One interviewee also believed these should not be seen as trends but as evolution in the construction industry.

A majority of the interviewees believed there is a market for reuse, especially for interior materials like ceilings, since products not visual in a complete building is hard to establish quality quickly. In that sense, the interviewees also meant some products are better subjects for reuse than others, highlighting the design phase as an important factor to work with reuse. One interviewee also believed there are too many obstacles today concerning reuse in the construction business and could therefore not answer if there is a market for reuse. Further, the interviewee added reuse might be feasible for smaller projects or renovations, but not for big

projects today. However, all interviewees believed there is a market for reused acoustic ceilings, where they explained acoustic ceilings as a typical and easily reusable product since it does not lose any functionalities over time and is not worn out. One interviewee was however concerned with the damage it could take during deconstruction.

Reference to a waste hierarchy was made by the majority of the interviewees when comparing the terms of reuse, recycling and refurbishment. Reuse and refurbishment are however seen as the same thing, albeit with a small alteration when refurbishing a material by some of the interviewees. Two of the interviewees define clear differences between the terms using examples where reuse was to move a product, recycling was to reuse the material for new products and refurbishment was to recondition a product.

A majority of the interviewees had also attended either internal or external courses or training on sustainability, with the focus on e.g. reuse, circular economy or sustainability in construction as a whole. One interviewee explained there were no courses specifically about circular economy for the entire organisation. Some interviewees also mentioned innovation projects as a source of education on the subject and how this could also help drive the industry forward in sustainability. Internal reuse has also been an educational subject in one of the real estate companies. One interviewee had not attended any internal or external courses on sustainability and implied there were other experts within the company with this knowledge already. The majority of interviewees also believed courses given by manufacturers concerning reuse would be interesting but one interviewee meant courses on reuse should be given to demolition companies since the knowledge around deconstruction work was perceived as low in the industry.

### **Project consultants**

Reuse was mentioned as the main trend within the construction industry by the interviewee. The trend was also believed to be relevant in the future with a need to see the value of reuse.

It was also believed there is a market for reuse, although it is hard to make it work. It was mentioned the items, products and materials that were viable for the market were items easy to handle and demount and move. For ceilings especially it was thought there is a market if the right conditions are met since the ceiling panels are fragile and the colour changes with age, but if they are refurbished this issue would be solved. The acoustic properties were believed to not change with age which makes the ceiling tiles a good candidate for reuse.

The interviewee explained reuse is using the product without altering it while refurbishing a product was returning the product and fixing it. Recycling was explained as melting or crushing a product to make new material or products.

Specific courses on reuse and sustainability were mentioned by the interviewee which also included economic aspects. Courses by the manufacturer were of interest if they included general aspects on reuse and were not based on specific products.

#### **4.2.2 Current practices on reuse**

Questions concerning current reuse practices were also asked to receive a view of to what extent reuse is practised in different parts of the chain. Topics involved were the type of materials reused, reasons for including reuse in projects, projects specific challenges, project design and purchasing platforms.

#### **Architects**

The interviewees explained they had been part of reuse projects, but explained examples of either refurbishment or recycling of products. One of the architects mentioned furniture refurbishment, where old chairs were repainted and received new dressing. The architect also mentioned an example for kitchens, where kitchen hatches had been spray painted instead of swapping them out and how they were very happy with the results. The other interviewee explained they had been part of an "adaptive manufacturing of wood" project, where recycled wood from waste streams was used, and how this process could be done seven times



for the same material. The reason for reusing was related to internal goals for one of the interviewees, and this goal was to use as many reused materials as possible in projects. Different challenges were also mentioned for these types of projects, such as inventory management where smart solutions for documentation was essential to make the process more efficient, as well as safety issues where the interviewee explained it takes a long time to develop materials for reuse because of fire safety regulations of products. One interviewee further explained reuse has not been a traditional way of working, but is becoming more and more relevant and will hopefully be considered for every project from now on.

Regarding purchasing reused products, one interviewee explained it is hard to know what products will be available at the time of the purchase and therefore added purchasing reused materials should be done locally. The other interviewee did not know how they would go about purchasing reused construction materials but added it is an internal discussion and ideas could be shared on the subject on a weekly basis. The deciding factor on whether reused materials would be purchased or not were either the availability of the products and how easy it is to prescribe them, as well as fluctuating construction product prices deciding what products will be used in the end.

### **General contracting companies**

Reuse has been a part of projects in GC companies, but at a small scale or for very few projects. Reuse is also not considered for every project unless the client asks specifically for it. Materials used in the reuse projects mentioned have mainly been concrete, doors and ceilings. The purchasing channels used were digital second-hand markets for construction materials or internally stored materials from previous projects. The reason why reused materials were part of the projects was to receive points for certifications or because it was convenient due to having material at hand. There were no standards apparent for how the projects should be designed for deconstruction, but one interviewee believed it would be important to plan for it early.

## **Real estate companies**

According to all the interviewees, reuse had been part of a project, whereas internal reuse was the most common practice. The most common reused materials were ceilings, internal glass partitions, armatures, doors and bricks. Carpets and gypsum boards were also mentioned once. The reasons for including reuse in projects were many, and the most common reason was GBC:s. Some interviewees also mentioned economic drivers, such as costs and that the cost of virgin building materials has increased over the past years. Reuse to ensure material quantities are met was also discussed. Internal policies of the company were also referred to as a reason for reusing building materials, where e.g. one of the companies works with 20 per cent reused or recycled materials as a goal for each project today.

Many challenges were also mentioned, where time, availability and quality of reused materials, logistics and warehousing challenges as well as different stakeholder mentalities and requirements were referred to the most. Where time and availability were referred to, the interviewees mentioned the construction business being competitive when it comes to receiving jobs and therefore not having enough time to wait for reused materials to become available. Some interviewees meant the market for reused materials today is too small and therefore a lot of time goes into picking out reused materials from different third-party sites (second-hand construction material websites). As for the quality of reused materials, there were concerns about fire safety as well as product ageing and some interviewees also added non-existent product assurances, insufficient govern legislation and standardisation around reused construction material as a challenge when including reuse in projects today. One meant an internal standardisation had to be done on what product types the company could offer their customers in a "reuse-condition". For the logistical and warehousing challenges, temporary storing and non-existent information labels of reused materials were mentioned and for those interviewees using reuse hubs for intermediate storage, administrative issues for material flows were mentioned as well. The mentality and requirements of different stakeholders were perceived as a challenge due to e.g. suppliers and demolition companies not showing interest in reuse, clients and architects having their requirements regarding materials as

well as the promotion of building with already used materials sometimes can be hard.

None of the projects was designed for reuse or disassembly, however, one interviewee uses hubs and QR codes to track their internal material flow to enable reuse. Non-internal reused products and materials were mostly procured through second-hand construction material websites by most interviewees, albeit one mentioned how this was outside their usual working ways. Another mentioned the suppliers pick up and buy back the material after they have been called by the real estate company.

Reuse is always considered for a new project by the majority of the interviewees, while two interviewees mentioned they are only considered if their client wants to use reused materials. The deciding factor if reuse is used is the availability of reused products as well as the increased costs. One interviewee also mentioned the quality of the products as a deciding factor.

### **Project consultants**

Reuse has been a part of projects where doors, roof tiles, bricks, ceilings and flooring were the products reused. Reusing materials were considered since it sometimes lowered the cost, while the environmental aspect was mentioned as an added bonus. The challenges during these projects were the added work and time it took to plan since more details needed to be considered and no projects were designed for deconstruction from the start.

Today, reuse is mostly done internally and privately, but it was mentioned secondary market hubs for reuse were used to look for material as well. From these hubs, materials could be prescribed to installers, but there were sometimes risks that the items listed could have been sold before the installers had the chance to buy them. Another risk identified was uncertainty about product quality and how this would be hard to monitor since the purchasing is done by the installer. Reuse is however always considered by the interviewee for new projects, due to laws of surveying what materials could be reused in a project. The deciding factor on whether or not reused materials are chosen for a project was however the

cost, the functionality and the quality of the products and how well the products complied with safety regulations.

#### **4.2.3 Considered aspects for reuse**

What the interviewees considered important aspects when purchasing a reused acoustic ceiling were asked, as well as their views on pricing, costs and assurances.

##### **Architects**

The architects explained the important aspects when purchasing a reused product to be quality, availability, clear information on the performance of the materials as well as information on what the materials contain. The last mentioned aspect was said by one of the interviewees to be the most important aspect out of all and both interviewees mentioned quality as an important aspect. One interviewee also added the importance of the appearance of the product and the possibility to process the material, as secondary aspects of importance.

None of the interviewees could explain what assurances would be needed for purchasing reused materials and one interviewee also added no assurances had been given for previous projects. The importance of price for a reused acoustic ceiling was also discussed, and both interviewees referred to price as an important factor. Both of them wished reused acoustic ceilings would be cheaper than new ones, but one said it could also be close to the price of the virgin product.

##### **General contracting companies**

Five different aspects concerning reuse were mentioned during these interviews; assurances, functionality, quality, economy and proof of climate impact. Among these five aspects, the ones considered most important were assurances, due to the responsibility the GC companies have to their customers in providing assurances themselves, and quality, with the argument a product can not be used if it does

not fulfil its requirements and a reused product must have the same properties as a new product, if it is going to be sold as one.

Regarding assurances for reused acoustic ceilings, insecurities involving product functionalities, exterior, and hazardous contamination are discussed. The interviewee meant assurances on these points are needed to feel safe purchasing it, and the reused products need to be quality tested when they are received back at a manufacturer. Warranties are also discussed to be needed and if no assurances are in place, the interviewee would not proceed with any purchase. However, it was also added they knew functional properties are kept for a long time and warranty subjects for ceilings are rare, but their customers receive warranties and therefore warranties are needed from the manufacturer as well, acting as a safety net. Both interviewees were confident they would buy a reused acoustic ceiling if assurances are in place.

The price of a reused acoustic ceiling is considered as important. The interviewees would pay the same price for a reused acoustic ceiling, compared to a new one and one interviewee might pay more if certifications are relevant for the project. Additional costs related to reuse, e.g. transportation, are also brought up as a cost wished to be avoided. Assurances would have no impact on the price since the product would not be bought without it.

### **Real estate companies**

Out of all mentioned important aspects concerning purchasing a reused acoustic ceiling, quality was mentioned by all five interviewees. With quality, they expected the reused ceiling to have a quality assurance and that e.g. there is a proof of its expected lifetime of the product and current properties. Availability, warranties and price were also mentioned by several interviewees. Logistical aspects, like easy pick-up and delivery, and time was mentioned once as well. Aspects that were added later by the interviewees were cost, visual appearance and CE marking. Quality was also perceived as the most important aspect by a majority of the interviewees, along with availability mentioned by one interviewee.

Quality assurances were deemed important if a purchase was to be made by four interviewees, but two added warranties specifically were not needed. One interviewee believed no warranties or assurances were needed at all for purchasing reused acoustic ceilings. All interviewees would purchase a reused acoustic ceiling if it had assurances. One interviewee mentioned they would only purchase the product if it had a quality assurance, but no warranties were needed. Another mentioned the cost should be less if there are no assurances, while another wanted it since it was seen as a safety net for the company, but it was not necessary. One interviewee was not worried about assurances at all.

Regarding the price that could be paid for a reused acoustic ceiling, all interviewees would pay the same price for a reused acoustic ceiling, compared to a new one. A majority of the interviewees deemed a quality assurance would be needed to pay the same price and added without any assurances, either no purchase would be made or the price would have to be cheaper since the real estate company would then take a greater risk. One interviewee also meant the price is compared closely to the environmental footprint of products while another also mentioned a higher price than virgin material would not be approved by company stakeholders.

### **Project consultants**

Three main aspects were mentioned for reuse. These were economic aspects, the function of the product and the time. The economic aspects were explained to be related to the cost of reuse compared to using virgin products, while the function of the products was related to the quality. The time aspects were explained to be related to delays because of the lack of availability of reused material on the market. Another minor aspect was the environmental footprint and the benefit compared to using virgin products, but this was a minor aspect where the economic aspects were deemed more important by the interviewee. The most important aspect was considered the economic factors since if the costs are too high, the project's budget could be used to improve other properties of the building.

When asked about assurances on previous projects where reuse had been a part

of the project, it was said none were in place. The interviewee also meant for specifically acoustic ceilings there was no need for any assurances since ceilings are considered a simple product. The price of the product was mentioned as an important factor and a reused product could not cost more than a virgin product. They could however cost the same as a virgin product, especially if there are assurances in place.

#### **4.2.4 Project influence**

As different actors in the chain might influence the design of a new project, the interviewees' perceived influence on new project designs and adoption of circular strategies, like reuse, were discussed.

##### **Architects**

The influence architects have on the choice of materials for new projects was perceived as high by both interviewees, but one meant it is always a discussion within project teams and they can not pick exactly what product it would be in the end, even though they have more influence today than before. The other interviewee believed they have a great responsibility as architects together with clients when choosing materials. Both interviewees also believed the client to have the biggest influence when it comes to implementing circular strategies in construction projects, but also added architects can help promote it as an alternative but how it is the client's choice in the end. One of the architects also mentioned everyone within the project has a say when implementing circular strategies.

##### **General contracting companies**

Both of the interviewees agreed the end-client has the biggest influence on the choice of material, however, they also believed GC companies do have an impact as well. One interviewee argued the earlier they got involved in the project, the easier it was to influence the chosen material. The nature of the project also

decides the influence GC companies have. Customers like real estate companies are also explained to have a drive towards circular strategies since they want to show they adapt to new environmental standards.

The end-client or real estate company were agreed upon by both interviewees to influence the most if circular strategies should be implemented in a project. Just like how the GC company has more impact on the chosen material if they are involved early in the project, they also have a larger impact on what strategies should be used for a project if they were a part of the project early in the process. One interviewee mentioned architects have an influence on the strategies and materials used as well, however, they act as consultants for smaller areas of the project and not for the project as a whole.

### **Real estate companies**

The stakeholders interviewed at the real estate companies had different perceptions about who has the biggest influence on the choice of materials in a new project. The majority believed themselves, as real estate companies, to have the highest influence, since they are the ones owning the buildings and therefore also have the possibility to decide the materials. One interviewee also mentioned real estate companies will have more power in the future and the construction industry is undergoing a shift towards more sustainable building. The end-client or the tenant was also believed by some of the interviewees to have the highest influence and architects were also mentioned to impact the choice of materials from the start of a project. One interviewee meant the end-client or tenant's requirements have a large impact and they rarely suggest reused materials for tenant improvements.

For adopting circular strategies in the construction business, however, all interviewees agreed real estate companies have the biggest influence. They thought tenants or clients are one step behind and they sometimes ask the real estate companies for advice on this matter. They also mentioned project managers or sustainability managers inside real estate companies usually drive sustainable construction forward. One interviewee also believed architects are the most creative stakeholders in this area, however not necessarily mentioning them as



having a high influence. Another interviewee also believed adopting circular strategies in the construction business needs to be a joint effort between all stakeholders involved, such as architects through design, construction contractors through encouragement and municipalities enabling it.

### **Project consultants**

The project consultant explained their client is the one in charge of what material is chosen, but the consultant has an influence as well and can give advice on what material is chosen. The interviewee further explained how this advice is usually followed, but in the end, it is always the real estate company, as the client, having the last say. The client is also the one deciding whether or not circular strategies are implemented in projects since they are the ones paying for the material.

#### **4.2.5 Drivers and barriers**

The interviewees were questioned on what drivers and barriers they saw on the topic and implementing circular strategies. Interviewees were also asked what the obstacles were during the process and the impact of certifications and regulations on the concept of reuse.

### **Architects**

The drivers towards working with reuse in the construction business were explained to be the sustainability perspective and recognition within the industry. With recognition, the interviewee meant there is a shift in society, where reuse projects are the ones receiving the most attention. The interviewees also mentioned barriers, such as costs limiting what can be used, availability of reused materials and the handling of it as well as barriers within warehousing. With availability, one interviewee meant that to be able to prescribe reused materials, architects need to make sure these materials are available when the project is being built. Warehousing was identified as a barrier due to recent discoveries where the architectural firm found products such as roof tiles, in good condition,

were crushed since there were no opportunities for storing or transporting the products for reuse purposes, and therefore crushing the roof tiles was easier. One interviewee also mentioned that the biggest obstacle was during the procurement and negotiation process since this is where the end choices are made on material purchasing.

GBC:s were perceived by one interviewee to follow the EU taxonomy and determine what loans are available. This interviewee also added they wanted to aim higher than certifications, but that one can not trust people's will when it comes to sustainability and therefore certifications and regulations are important since there is a bonus for companies working with GBC:s. The other interviewee could not answer what impact certifications have on the concept of reuse.

Regulations were also said to be important and there is an economic side to the taxonomy. Both interviewees also meant circular design strategies help create new possibilities and challenges to overcome. One of the architects explained they work a lot with this, especially on how to design strategies for the future.

### **General contracting companies**

The main drivers identified by the employees at the GC companies were future aspects and climate questions. The future is explained as a driver in the sense that leaving a better world for the next generation should be enough to start caring about more sustainable construction. Climate questions were explained as wanting to have an environmental brand image and through reuse this can be obtained. European regulations and taxonomy were also explained to have a direct impact on Swedish certification systems and how this in turn has an impact on the end client.

The main barriers were explained as either none, by one of the interviewees, or many by the other interviewee. The interviewee who referred to many barriers explained finding reused material is hard and there is no time to wait for material since speed in projects is important. Warehousing issues for GC:s, new purchasing processes and material handling were also added as a barrier, due to the probability of falling into old ways of purchasing and handling

material because of the simplicity of using these traditional ways. Shifting from the traditional ways of purchasing materials was seen as the major barrier by one of the interviewees. Other barriers mentioned were the lack of individual knowledge, standardisation and government legislation around reuse and how this causes companies to work in different ways with reuse, making it cost-ineffective. Reusing could also cause the loss of product quality certification which was seen as a problem by one of the interviewees.

Certifications were explained to be considered in the planning process for new projects and both companies have worked towards either Miljöbyggnad Silver, Nordic Swan or Noll CO2. Both interviewees believed there would not be built as many green buildings without the certification systems and one exemplified this when sustainable construction, in earlier days, was promoted by the state and real estate companies received financial contributions as an incentive to build more sustainable.

### **Real estate companies**

Drivers identified by the interviewees from real estate companies were created savings through reuse, personal drivers and climate thinking. The interviewees meant money can be earned through financing, from e.g. banks, of sustainable buildings and not necessarily cheaper materials. They also meant certifications can create savings. The personal drivers and motivations were mentioned as engagement in climate thinking from project leaders and relevant stakeholders as well as curiosity.

The main barriers identified by the interviewees were the availability of reused materials and the issue of receiving reused material at the right time in a project, lack of interest from clients, costs, regulations, logistics and warehousing issues as well as various mentalities for sustainability in the construction industry. The interviewees believed it is hard to incentivise demolishers to work with reuse and since there is no third group in between installers and demolishers who handle deconstruction, this was seen as a barrier. They also believed deconstruction of building materials and storing materials on construction sites to be transferred as reused materials take a lot of time and costs a lot of money. As mentalities

in the construction industry differ, one interviewee believed traditionality and inflexibility within the construction industry was an issue as well, creating limitations towards working more with reuse. One interviewee also meant it is hard to guarantee a supply of reused materials, which makes it difficult to prescribe reused materials in the planning process.

Regulations and laws were also believed by some interviewees to halt potential requirements of reuse, with no existing standard for working with reuse. Some interviewees said regulations are supposed to be the future for working with reuse, since companies need to adapt to construction laws and this, in turn, could help create competitiveness in the construction industry, competing on who can deliver the most sustainable construction projects. They also believed construction should be regulated on a wider scale, i.e. regulated by the European Commission. The interviewees also meant with regulations, standardisation could follow and standardised products for reuse would be easier to prescribe in the planning phase. Since banks only finance projects following regulations, the importance of regulations was perceived by an interviewee to have a high impact on construction projects. One interviewee did not know how regulations have an impact on the construction industry and reuse.

GBC:s were said by interviewees to have a high impact on the planning process of new projects. They meant GBC:s steers the construction work and processes and helps lead sustainable construction forward in the industry. Mentioned GBC:s were Miljöbyggnad Gold/Silver, BREEAM-SE and NollCO2. A majority of interviewees explained they work with GBC:s for all their projects.

Most interviewees believed GBC:s are needed to create a more sustainable construction industry, and that sustainable thinking is not enough. One interviewee added that before GBC:s all focus had been on minimising costs for projects and another interviewee explained GBC:s are important to receive financing from banks. One interviewee thought awareness of sustainability and long-term sustainable building was a more important driver than GBC:s since there were no economic incentives for the company to work with GBC:s because it was owned by the state.

### **Project consultants**

The main drivers identified by the project consultant were social feelings and ambitions for the environment, as well as the economic drivers in lowering costs using reused materials and products. The barriers were related to the aspects mentioned earlier. The interviewee explained it takes more time, costs more and the quality is worse than virgin products today. Since this was the case, the interviewee further continued explaining how every single aspect needs to align to reach the economic goals of the project. If the aspects did not align, virgin products and materials were used instead. Laws and regulations were mentioned by the interviewee to have an impact, especially on standardisations.

The interviewee explained certifications have a large impact on the project and the project design, and further explained without certifications there would be less sustainable building within the industry since real estate companies can no longer show their customer or the public they are a sustainable company. It was also mentioned if certifications have an impact on the project design, so should circular strategies.

#### **4.2.6 Future visions and ideas**

The future visions and ideas regarding reuse were lastly brought up and their expectations on how reuse could be established in the future.

### **Architects**

Several ideas were mentioned on how to make reuse a more widely adopted concept, such as the need for incentives within the construction industry to reach climate goals. One interviewee meant there is a need for a standardised system without odd products and a possibility to judge the quality of materials through standards. The interviewee further explained every business needs to find an open business model for reuse in the future to enable collaboration between different actors in the chain.

A dream service was described by one of the interviewees as a digital solution or

a database that could show what the market looks like, also from a geographical point of view. The interviewee would also like to have early information on what is planned to be demolished and know what can be saved from the project and used as reuse. Lastly, the interviewee wished to be able to test different scenarios and know what reused material is available as well as relevant information concerning the available reused products.

### **General contracting companies**

Several ideas on how to make reuse a more widely adopted concept were mentioned by the interviewees. Pilot projects were explained to be a good way to try theories and also have a good impact in showing the concept of reuse works in practice. It is also explained how the market needs to grow and the availability of materials needs to increase since there is no easy way to gather reused materials today. One interviewee also mentioned the state or municipalities should have warehousing sites available for temporary storage of products for reuse and how conditions and standardisations around this and reuse in general are needed. Since the demand by the end client is perceived as too low, they need to become engaged in environmental questions and understand what an environmental profile means. One of the interviewees also encouraged companies to market reuse and make sure customers know it exists.

As for dream services, the interviewees would like the original manufacturer to offer reuse as part of their product portfolio and it should be easy to compare reused and virgin products by means of cost and environmental footprint. Logistics were also wished to function the same way it does for new materials, without any additional costs e.g. freight of reused materials.

### **Real estate companies**

To make reuse more widely adopted, regulations were mentioned to help facilitate it. This included standardisations of products and setting standards on the percentage of reused materials and products for a project, while also including EU taxonomy as an incentive when reuse is used. Another idea was to create

and scale up purchasing platforms where the producer needs to take more responsibility due to new requirements on the real estate business as well as market reuse to show reused products are available. Real estate companies and project leaders should also include reuse requirements early in a project. It was also said that reused products need to be proven to be as good as new products. The specific stakeholder demolition companies were mentioned to need to be able to see the business opportunity regarding reuse while spreading knowledge to installers about reused products on the market. Giving installers the option to easily choose reused material when asked for was brought up by another interviewee.

The dream service for the majority of the interviewees was a simple solution to finding reused material and products and wanting it to be easy to pick up or have the products delivered to them. Two of the interviewees specifically mentioned the manufacturer or supplier should offer reuse since this would include less risk regarding the quality of the products. A digital platform was wished for where if there were not enough reused products in stock, the order could be complemented with virgin products. Less product variety for reused products was mentioned by one interviewee as well. Another interviewee had internal reuse within the company as the dream service. Meaning internal assets within the real estate company would keep track of reused products in the warehouse, while also using third-party platforms to order reused materials when needed.

### **Project consultants**

No concrete ideas were mentioned regarding making the concept of reuse more highly adopted, but the project consultant believed the producers need to deliver the service of reuse, meaning reuse should be included in the product portfolio for the producing company and a choice between virgin and reused material should be present when ordering products. The interviewee also believed acoustic ceilings could be deconstructed and sent back for refurbishment at the original company and then shipped out as a refurbished product. The dream service was explained to follow what is mentioned above, also adding this would enable prescribing of reused material with similar properties as a virgin product. The

consultant also described, from the case company's point of view, since architects prescribe materials for projects, there needs to be an availability of reused acoustic ceilings at the case company so this can be prescribed, otherwise, they would not prescribe it.

### **4.3 External interviews - implementation phase**

#### **4.3.1 Perception and knowledge of sustainability**

The interviewees involved in the implementation phase of a project, i.e. installation companies and demolition companies, were questioned on the topic of sustainability, circular economy and reuse. Questions asked involved current trends in the construction industry, the perception of a market for reuse, as well as sustainability training, like internal or external courses.

#### **Installation companies**

The key trends identified by the interviewees were recycling and reusing construction materials, especially hard materials that are easy to handle. The trends were believed to stay relevant in the future where one interviewee mentioned the importance of creating circular flows to make it work. The other interviewee meant the trends could not continue without economic incentives since the industry is very cost dependent. It is also mentioned the trends had to start with larger companies.

Both interviewees believed there to be a market for reuse, where one believed it is already active today for smaller projects and buildings and the interest in it is growing. The materials to reuse were said to be roof tiles, light armature, doors, ceilings and windows. One interviewee highlighted the need for the product or material to have a higher or special value e.g. old bricks that can not be bought anymore. The views were split when it came to reusing acoustic ceilings. One installer believed there is not enough embedded value in the products, making them more viable to recycle instead, while the other saw the demand for it today



from real estate companies and wanted to be able to provide reuse as long as the customer wanted it.

Recycling was seen by both interviewees to be the practice of breaking the product down and repurposing it into a new product, while reuse was believed to simply just move the product to a new location. Refurbishment was explained as the practice to repaint, wash or upgrade the product. One installer mentioned it would be hard to just reuse and refurbishment might be a must. One interviewee had attended courses by the manufacturer and mentioned the importance of keeping up to date with new information. The other installer had no interest in courses and had not attended any since it was believed there is no market for reused acoustic ceilings today.

### **Demolition companies**

Trends in the construction industry were mentioned to be ecologically sustainable thinking by one interviewee and reuse by the other. The first mentioned interviewee believed the trend will continue for some time until it ends since it is possible to work around some sustainability questions, while others are impossible to solve. The second interviewee said the trends will continue and regulations regarding reuse will follow.

Both interviewees believed there is a market for reused construction materials, one mentioned specifically for bricks and wood, but not a widespread market nor a market for reused acoustic ceilings. One meant it takes too much time to deconstruct and there are no economic incentives for reusing acoustic ceilings. The other interviewee thought there will be a market in the future, but the lack of economic factors and regulations makes it difficult to achieve today.

The first interviewee saw recycle and reuse as the same thing while being unable to define what refurbished was. The second interviewee defined reuse as using the product again as it is and recycling as making a new product with the material of the old one. Refurbishment was seen as the same thing as reuse. One interviewee had no interest in courses about reuse at all and wanted to keep working the same way they had always done. The other respondent had done courses and

was interested in courses by a manufacturer about the specific reuse of acoustic ceilings since the interviewee had a personal interest in reuse and sustainability. Lastly, the first interviewee meant reuse is important and would be of interest if they were given enough time and incentives to be able to reuse.

#### **4.3.2 Current practices and aspects for reuse**

Questions concerning current reuse practices were asked to the employees at the installation companies. Topics involved for them were the type of materials reused, reasons for working with reuse in projects, project specific challenges and barriers related to reuse as well as material prescriptions and purchasing platforms. The demolition companies were asked questions concerning selective demolition practices. Topics involved were which materials usually are salvaged respectively destroyed, encountered challenges and barriers as well as incentives for selective demolition.

#### **Installation companies**

Both installation of reused products and selective demolition had been practised by one of the interviewees while the other only had been part of installation projects. In the installation projects, the interviewees gave examples of projects using either reused bricks, with a special appearance, and internal reuse of ceilings which was ordered by a real estate company. The reasons for working with reuse were either because the specific product was perceived to have value or because the real estate company wanted to reuse internally to save money on a project. The encountered challenges in the projects mentioned were time planning, quality and differences in appearance between reused products, logistics, warehousing and transports. One interviewee further explained there was more transportation involved than in regular projects and products were warehoused for too long. It was also believed by the interviewees' reuse would be part of all projects very soon, but only for certain materials and products.

How reused materials would be purchased today could not be identified by one of the interviewees, while the other explained there were local storage units

where reused products such as windows could be purchased. The interviewees also identified functions, warranties, quality controls, documentation of products' current state, environmental footprint proofs as well as proof of non-hazardous substances to be aspects that would be considered when purchasing a reused product. One interviewee further explained if a reused product is to be sold as a new product, some kind of assurance and responsibility needs to be given by the manufacturers. The importance of price was also discussed, where one of the interviewees believed it is a crucial factor when purchasing a reused acoustic ceiling, and added how the price of a reused product determines which companies have the possibility to buy it. Therefore the interviewee also added that reused acoustic ceilings need to be cheaper than virgin ones since they have already been used and that is how the second-hand business works today. The other interviewee meant if the price is too high, only the large real estate companies would pay for it, and further explained the price is not an important factor for the installation companies, as long as the real estate company is ready to pay for it. Damages caused by the transportation of reused products were also mentioned by one interviewee, and this needs to be considered when pricing reused acoustic ceilings.

None of the interviewees would feel comfortable purchasing reused acoustic ceilings without any assurances since they need to be assured of the product quality and they cannot go around client demand on assurances. One interviewee also mentioned it would be comfortable purchasing a reused acoustic ceiling from a business point of view if there were assurances, but it did also not feel completely right from a moral perspective, knowing the reused product does not meet the same requirements as a new product. No assurances were mentioned to be part of previous reuse projects, except for in-house acoustic testing for internal reuse, made by the real estate company.

One interviewee meant the construction industry is a slow-moving, conservative industry and that this could be seen as a barrier for reuse, while the other interviewee explained the costs and price of reused products as a barrier as well. Regulations on the concept of reuse were perceived by the interviewees to have a large impact and regulations are needed to further adopt reuse in the industry. Incentives were mentioned to be needed and moral aspects are not enough to

make reuse highly adopted.

When it comes to selective demolition projects, the interviewee involved in such a project explained they usually avoid them as it is not their original type of business. However, for that specific project, the interviewee explained ceilings were moved from one location to another in the span of a couple of weeks, as requested by the client. Challenges for the project were mostly logistically related, such as difficulties and time spent at sorting and marking the reused products. Some products intended to reuse were also perceived to not fulfil the quality requirements after they had been mounted, creating double work for deconstructing and installing. The interviewee also meant more incentives were needed to work with selective demolition, such as an understanding from clients on the additional time deconstruction takes compared to demolition, as well as logistical opportunities needed such as safe warehousing of materials intended for reuse and less transportation.

### **Demolition companies**

One of the interviewees had been part of both installation and demolition projects. For installation practices, the interviewee explained reuse had not been part of a project and is never considered. The interviewee believed reused and recycled materials are too expensive and it is always more expensive than virgin materials as a rule of thumb, therefore the interviewee would not consider purchasing reused acoustic ceilings unless it is cheaper and is quality tested by the manufacturer. The interviewee believed reused acoustic ceilings should be cheaper than the virgin product since as a reused material it has already lost its original value and warranties are not feasible since reused materials have been processed and there is no way to tell the standard it holds. Therefore the interviewee would also prefer to buy virgin acoustic ceilings if a choice was given between virgin and reused acoustic ceilings.

Both interviewees had however been part of a selective demolition project, where salvaged materials were lamps, doors, windows, roof tiles and rare stone materials. The reason for salvaging some material for reuse was due to the real estate owner or client-requirements. One interviewee also added the real estate

company or client wanted their company to be at the forefront of sustainability and did not care what would happen to the material once salvaged, but still wanted to know where it went after the selective demolition project. For one of the cases, one interviewee explained that deconstructed materials still belonged to the real estate company and therefore the interviewee could not tell what happened to the salvaged materials afterwards, but in the other case, the other interviewee explained the deconstructed materials belonged to the demolition company and therefore salvaged material was sold as reuse to other countries demanding it for projects, either via second-hand markets or through mouth-to-mouth sales. The salvaged materials that did not sell, would either be recycled or end up as landfill. The interviewee also added more salvaged materials could probably be sold if yard sales could be held at the deconstruction site, however, this was not feasible due to safety concerns on demolition sites.

Several challenges were encountered by the interviewees during the selective demolition project and one interviewee explained the problems start at the beginning, establishing what materials are worth salvaging as reuse since if the probability of materials becoming destroyed when deconstructed, it would not be worth to deconstruct them in the first place. The interviewee further explained it is hard to take on deconstruction projects since the demolition business works with tight schedules and the client does not understand or want to pay for the extra time it takes to deconstruct materials on site. Both interviewees meant deconstruction takes longer time than demolition and that this is not a traditional way for demolition companies to work. Warehousing and storing of salvaged materials was also seen as a barrier since it takes up a lot of space on the actual demolition site and there is usually no good place to put the materials for intermediate storage. Since only the demolition company may enter the premises at the time of the demolition project, one interviewee meant nobody else can do the deconstruction work and bring the materials with them. The interviewees also meant there are generally no economic incentives yet for the demolition companies to work with reuse or selective demolition.

Regulations were also discussed with the interviewees, where one of them thought regulations on reuse would not appear in Sweden, but if they did then of course the company would have to adapt to the laws given. The other interviewee

believed regulations on reuse are needed for the market to develop since there is no clear information on who is responsible for reused materials and who should handle the storing of them.

#### **4.3.3 Project influence**

As different actors in the chain might have an influence on the design of a new project, the interviewees' perceived influence on new project designs, selective demolition and adoption of circular strategies, like reuse, were discussed.

#### **Installation companies**

One installer believed they did not have a lot of influence on the chosen product. It was mentioned they are able to propose similar products to what was prescribed, but generally want to stick to purchasing the prescribed products. A reason to swap out products could be related to money as well as the weight of the products. The other installer believed they had a larger impact on the choice of products, especially if there was a mistake or it was believed the wrong product was to be used. It was then possible to discuss with the client and since the installer has expertise in acoustic ceilings the change usually went through.

None of the installers believed they had any impact on choosing to use circular strategies or not in a project. This since they are involved in the project at a later time than when these strategies were discussed to be used. One installer had no interest in being involved in it either. Both of the interviewees also thought architects are pushing the strategies to be used and doing so together with the real estate companies.

#### **Demolition companies**

When it came to influence on the design of the project, both interviewees answered they had none at all since they are subcontractors. If the demolition company was the general contractor of demolishing, however, they explained

them having more influence and could choose what materials and products to reuse and recycle, but further explained this would rarely occur. When the demolition company was not the general contractor, the real estate company or owner of the demolished building was asked for ownership of the waste material to be able to influence what type of demolition was to be done. When reuse was possible there needed to be a buyer and the timing needed to be correct for reuse to be considered. None of the interviewees had any influence on the chosen material and real estate companies were perceived to have the greatest impact and influence on the project. It was also added the tenants had no influence at all on the design of the demolition project.

#### **4.3.4 Future expectations and ideas**

The future expectations, incentives, visions and ideas regarding reuse were lastly brought up and their expectations on how reuse could be established in the future market.

#### **Installation companies**

The expectations on reuse were for it to continue to grow in the future by one interviewee and an idea of receiving some kind of bonus if reused products were used while building was brought up.

Both installers would like to purchase reused products from the manufacturer. One wanted this since they believed manufacturers are the ones who could solve the logistical problems. The other wanted the products to be packaged the same way as new products since the ceilings are frail and received damage during transportation otherwise. The installer who also had demolition experience wanted the return service for returning materials to be efficient and effective and could be combined with the delivery of new products. The pick-up should only be made when there are a sufficient amount of products for it to create the value needed.

The dream service for one of the installers was for the quality to remain high for

the products. This meant the ceiling should retain at least 90% of its acoustic properties, there should be no discolourations and come in new packaging just as virgin products. The interviewee wanted to be able to purchase the reused products through a website as well. The other installer focused more on the dream return service. The interviewee mentioned a well-functioning logistics network to enable sending reused products back to the manufacturer without a lot of administrative work together with incentives for the products they send back. A need for the manufacturer to listen to feedback from the customers was also highlighted after they had been a part of a recycling project where they believed they were not listened to.

### **Demolition companies**

One interviewee had expectations of the products to be easier to reuse and deconstruct by the design of it. It was also mentioned being better to reuse products with high value since they were deemed to retain more value. The other interviewee had no expectations. To be able to deconstruct, more time was deemed necessary, while one interviewee wanted higher pay as well.

For reuse to be considered on a greater scale, it was mentioned by an interviewee the reused products had to be allowed to have other standards than a virgin product, using the help of regulations. The interviewee also meant people have to accept a worse quality than a virgin product overall. A points system for reused material and products by regulations was also discussed. The other interviewee had no ideas regarding making reuse more widely adopted.

The return service was to be kept simple. One respondent wanted to be able to take a picture of the products and then have someone come and pick it up if it was deemed usable. It was mentioned it could be done using an app. It was also important no extra costs were added and the demolition company was not to pay more to be able to reuse since it already took more time to deconstruct. The other respondent was disinterested in the method unless a higher wage and more time were given because time was becoming more and more valuable within the industry.



## **4.4 Typical stakeholders**

### **4.4.1 A typical internal stakeholder**

**The typical internal stakeholder can be described as:**

- Seeing reuse as a trend with an increased demand
- Having high sustainability knowledge, but believes there are gaps between presented knowledge in internal courses and current individual knowledge
- Believing installation companies have the highest influence on the choice of materials
- Seeing deconstruction of acoustic ceilings as a simple practice

**The offer the typical internal stakeholder believes in includes:**

- Selling a reused acoustic ceiling for the same price as the virgin product
- Not offering any warranties, since they should not be needed and is hard to provide for a reused product
- An E-commerce platform where customers can purchase products online

**The problems the typical internal stakeholder sees with reuse are:**

- Low availability of reused construction products on the market today
- Landfill is too cheap and is preventing reuse practices
- The industry is slow-moving and inflexible regarding changes

### **4.4.2 A typical planning phase stakeholder**

**The typical planning phase stakeholder can be described as:**

- Seeing reuse as a trend

- Believing real estate companies or the end client has the highest influence on the choice of materials and circular strategies
- Seeing GBC:s as a driving force for working with reuse in construction projects and is a more important driver than just environmental questions and goals
- Having high sustainability knowledge

**The offer the typical planning phase stakeholder believes in includes:**

- A reuse service offered by a company producing the original product
- High product quality
- Quality testing but not necessarily warranties
- A simple procurement process
- Educational courses around reuse
- Purchasing a reused acoustic ceiling for the same price as the virgin product as long as quality assurances are in place

**The problems the typical planning phase stakeholder sees with reuse are:**

- Low availability of reused construction products on the market today
- Warehousing and intermediate storing issues
- Lack of standardisation and regulations for working with reuse

**4.4.3 Typical implementation phase stakeholders**

Two typical implementation phase stakeholders are created due to the installers mainly received questions about installation practices while the demolishers mainly received questions about selective demolition practices.

**The typical installer can be described as:**

- Seeing reuse as a trend but having split opinions on reusing specifically acoustic ceilings
- Believing the end-client or the real estate company has the highest influence on the choice of materials

**The offer the typical installer believes in includes:**

- A reuse service offered by a company producing the original product
- Proper packaging of reused acoustic ceilings
- Warranties, quality assurances and documentation for the product
- Procurement through an E-commerce solution
- A price the real estate company or end-client is ready to pay for in the end

**The problems the typical installer sees with reuse are:**

- Quality and visual appearance of reused acoustic ceilings coming from different batches
- Logistics, warehousing and transportation
- The industry is slow-moving and very conservative regarding changes
- High costs and prices of reused products today

**The typical demolisher can be described as:**

- Working in a business that is very pressed for time
- Always willing to do the work ordered by their client, as long as it is profitable for the demolisher's business
- Believing their influence in selective demolition projects is limited

**The offer the typical demolisher believes in includes:**

- Economic incentives to work with reuse
- A simple and efficient logistical system with a pick-up of materials on the demolition site
- No extra costs are added for the demolition company to work with selective demolition compared to traditional demolition

**The problems the typical demolisher sees with reuse are:**

- The client not understanding the extra time deconstruction takes compared to demolition practices
- Logistics and warehousing issues, such as storing material on the demolition site

#### **4.5 Literature review**

Reuse was deemed an option when the demolition contractor can identify three different conditions. The conditions are the following [van den Berg et al., 2020]:

- The demolition contractor identifies an economic demand for the element.
- The demolition contractor distinguishes appropriate routines to disassemble it.
- The demolition contractor can control the performance until integration in the new building.

For the first condition to be fulfilled, the demolition contractor needs to realise there is an economic demand for the building element and see the value in the product for reuse. This realisation of economic demand was usually made on-site using the knowledge of the demolition workers [van den Berg et al., 2020].

The second condition to be able to disassemble or deconstruct the product depends on the knowledge of the demolition worker as well as the design of the

product. The worker needs to know the disassembly routines for the specific type of product, while the product needs to be easy to move or deconstruct without damaging it [van den Berg et al., 2020].

The third and last condition was controlling the future performance of the product for it to contain the value. The largest concern for this condition was storing and transportation of the product as well as enough time given to be able to disassemble properly without damaging the product for the demolition contractor. Another point raised by the demolition worker was the cleaning of the product to be able to increase the value of it and reach an acceptable level for reselling, which once again demands more time [van den Berg et al., 2020].

Unless all three of these conditions are met, the product or element will enter the normal waste stream and be either recycled or sent to landfill at its EoL [van den Berg et al., 2020].



## 5 Analysis

*In this chapter, theory and empirics will be combined to establish a generic analytical framework for reuse within the construction industry. The drivers, inbetweeners, barriers, needs and industry gaps have been identified and will be analysed to enable a best practice for the case company and a conclusion for this thesis.*

### 5.1 Analytical framework

The analytical framework presented in figure 17 summarises the empirics and describes what different codes can be seen as either *drivers*, *inbetweeners*, *barriers* or *needs* to conceptualise a market for reuse. This framework was developed by firstly categorising the qualitative data gathered from the interviews and the literature review into what could be perceived as either a *driver* or a *barrier* for reuse. After some further analysis, it was evident not all data could be translated into simply a *driver* or a *barrier*, hence the need for two more sections was identified, thus *inbetweeners* and *needs* were added to the final version of the DIBN-framework.

DIBN is an abbreviation of drivers, inbetweeners, barriers and needs, and all codes can be connected to one or more input categories, such as stakeholder perceptions, policies, knowledge, project influence and ideas, as well as local or European regulations and reuse aspects to be mainly considered in a reuse-offer. Within some codes, gaps in the industry were clearly evident as well. By realising the drivers, inbetweeners, barriers, needs and industry gaps it is possible to enable a general offer for the reuse market as well as establish a best practice for the case company, enabling short term and long term success.

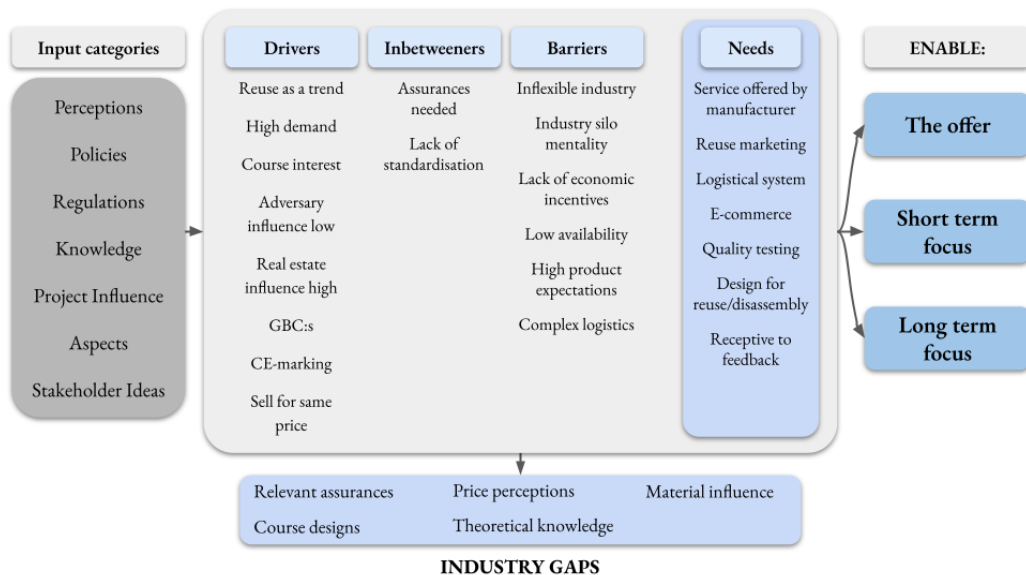


Figure 17: The DIBN-framework, own work

## 5.2 Drivers

During interviews, the majority of all stakeholders saw *reuse as a trend* that will continue being relevant in the future. This can be seen as a driver since this means the relevant stakeholders have heard of the concept in connection to the construction industry and also have an interest in working with reuse both in the short and long term, which is also a result of the *high demand* of reused products today. This answers yes to the question if a second-hand market exists, which can be seen in the circular marketing mix in figure 8 in chapter 3.2.2. This can also be connected to figure 15 in chapter 3.5 as a social driver with the motivation from being a part of a group or community working with reuse. Furthermore, the *course interest* stakeholders have in courses given by a manufacturer can also be seen as a social driver, since spreading information and awareness to others could have an impact on the social environment and create wished behaviours around reuse as well as motivate others to take part in reuse practices.



*Real estate companies having the highest influence* on the choice of materials can also be seen as a driver since they also show a high interest in working with reuse. They also have a high influence on whether circular strategies are implemented in projects. Together with architects, who are also promoters of circular strategies, they share similar opinions on working with circularity in the construction business which can be seen as a crucial driver due to the need of involving circular strategies early in the planning process to enable circular supply chains and help to design the "use" and "recover" processes, seen in figure 6 in chapter 3.2.1. As the *adversaries*, i.e. mainly ceiling installation companies and demolition companies, have a *low influence* on the choice of materials, this can also be seen as a driver since these two types of stakeholders will follow the client requirements in most cases.

*GBC:s* can also be seen as a driver for reuse. It is evident from the interviews with real estate companies and other planning phase stakeholders *GBC:s* plays a large role when designing projects. Some *GBC:s* award credits specifically for reusing materials in projects and this can be seen in the Miljöbyggnad example presented in figure 11 in chapter 3.4.3. Miljöbyggnad was also the *GBC* mentioned most in the interviews and it is also the biggest *GBC* in Sweden. *GBC:s* can also be connected to figure 15 in chapter 3.5 as a material driver since real estate companies work with *GBC:s* due to the direct financial rewards and benefits received from certifying buildings and projects. Certifying projects generally increases the economic value of a building and real estate companies receive public relations from working with *GBC:s*. As mentioned in chapter 3.3.5, special financing of projects following *GBC:s* is also an explanation for why real estate companies work with *GBC:s* and this was also mentioned in the interviews.

Some interviewees also mentioned *CE-marking* as a quality assurance when it comes to purchasing reused products. In chapter 3.3.2, the possibility to *CE-mark* reused products is a topic currently being discussed in the EU commission and if the product can fulfil its virgin requirements this can also be seen as a driver for reuse in the future.

According to a majority of the interviewees, they would be willing to pay *the same price* for a reused acoustic ceiling compared to the virgin product. This is due to the social- and material drivers presented around reuse and environmental

aspects becoming more comparable with the price. This can however also be seen as a driver for reuse since it opens up a higher possibility to profit from a reuse service offered by a manufacturer, as well as decreasing the risk of cannibalising already existing virgin products in the product portfolio.

### **5.3 Inbetweeners**

An inbetweener can in this report be defined as aspects that contain both drivers and barriers and is therefore hard to directly place as either a driver and barrier without any further analysis.

What can be claimed to be an inbetweener is first of all assurances. From interviews, it is evident that customer *wants assurances*, and more specifically quality assurances of reused products and not necessarily warranties. The pros of delivering a quality assurance is the opportunity to create a higher service level to customers. This in turn would also help create a better brand image. As quality is the aspect that was found most important among all interviewees, this also means it becomes an order winner for the customer, as discussed in chapter 3.2.2. The cons of having to provide a quality assurance are costs and time. Quality testing of returned products could become very costly and also very timely without a proper system functioning around it.

*Lack of standardisation* from regulations can also be seen as an inbetweener. The interviewees meant some kind of standardisation created by the upper level, i.e. governments, or the EU-commission, needs to be in place to adopt reuse further and also create a quality standard for reused products, which makes non-existing standardisations a barrier today as well as the uncertainty of what regulations will appear in the future. However, this also creates an opportunity for a manufacturer to create their own standards of what products could be deemed as reusable, creating a larger market opportunity for the said manufacturer.

## 5.4 Barriers

Interviewees mentioned how *inflexible the industry is*, or how slow it adapts to changes. This is a clear barrier when it comes to reuse. The inflexible industry combined with *industry silo mentality* creates an environment where changes are not easily made since information sharing is low and therefore challenges in each business group are not always apparent to everyone involved in a construction project. To reduce this barrier, the four dimensions of management seen in figure 14 in chapter 3.5 can be used, with a special focus on increasing collective wisdom. This would help innovate the concept of reuse further and find a common ground for what challenges needs to be dealt with. For this to happen, information sharing between businesses needs to increase as well.

*A lack of economic incentives* to work with reuse was also brought up in the interviews with demolition companies. This can also be seen as a barrier since in the long term, demolition companies might become even more restricted towards reuse and selective demolition if no economic incentives are added for them. If economic incentives for demolition companies are created, the barrier can be turned into a material driver, as illustrated in figure 15 and discussed in chapter 3.5, and this is vital to create a well functioning RL-system and create the wanted behaviour.

*Low availability* of reused products as well *high product expectations* are two barriers that can be turned into one amplified barrier. Searching for reused material with high quality becomes increasingly difficult when there is low availability on the market. This also highlights the issue of finding reused materials with similar appearance and in the right amount. This barrier can be dealt with by turning the manufacturer into a gap exploiter, as can be seen in figure 7 in chapter 3.2.1. As a gap exploiter, it is crucial to create closed loops to collect items for reuse, i.e. a RL-system. It is also crucial to make sure that the collected items also can fulfil the high product expectations customers have. Interviewees also mentioned a manufacturer knows their product best and is, therefore, best fit to determine qualities and what products can be deemed reusable, hence it is also argued the manufacturer should be the gap exploiter.

*Logistics* was mentioned by the majority of the interviewees to be a complex topic

to handle and therefore also a barrier. This includes warehousing, transportation and intermediate storage like e.g. storage on demolition sites or storage hubs. To deal with this barrier, a relevant acquisition archetype, as described in chapter 3.2.3, needs to be decided taking into account costs, consumer convenience and collection capacities. What interviewees pinpointed were mostly connected to costs and consumer convenience but the manufacturer also needs to take into account the collection capacities. This will be discussed further in chapter 5.5.

## 5.5 Needs

The general need that has been identified is the reuse *service should be offered by the manufacturer*, as this is a possibility for the manufacturer to become the gap exploiter which was discussed in chapter 5.4. To exploit the gap and retain the value of the products, flow management and RL should be used by the manufacturer for reuse services. This would also make it easier for the demolition contractor to identify an economic demand for the product while taking control of the last condition mentioned in chapter 4.5. There is also a need to apply the *circular marketing mix*, seen in figure 8 in chapter 3.2.2, to the reuse offer and to further enable a circularly designed logistical system. Therefore, the new circular logistics-related questions from figure 8 can be extended, and the specific question that will be answered is how the *RL-system* should be designed for reuse logistics.

Since convenience is of high value to demolition companies as well as other stakeholders involved, there should be a door-to-door pick-up, mentioned in chapter 3.2.3, with an *internet-based solution (e-commerce)*. E-commerce solutions were also mentioned by many interviews as a need to increase the visibility of available products, virgin as well as reused. The RL-system should also follow the RL processes framework seen in figure 9, especially during the setup of a RL-system. Here, credit rules should be created since this would create the demanded incentives for the stakeholders, highlighted by the implementation phase stakeholders. To further be sure of the quality of returned products before crediting, there is a need to trace the products to make sure the products are not contaminated nor used in an environment unfit for reuse as discussed in chapter

### 3.2.3.

After receiving the returned product it was also discussed in chapter 5.3 that quality assurances was seen as an inbetweener. However, since quality was deemed to be an order winner, the need for *quality testing* is evident. The disposition needs to be chosen as well for the quality-tested products. If the products do not qualify for direct reuse, they should be sent and routed for either refurbishment, remanufacturing, repurposing or recycling, following the 9R waste hierarchy from figure 5 in chapter 3.1.2, to still enable a contribution towards a more circular economy.

Along with quality, the availability, price and simplicity were aspects mentioned that can be seen as order qualifiers, mentioned in chapter 3.2.2, since if the price is too high or the availability is non-existent, no purchases of reused ceilings would be made. Simplicity was increasingly important for demolition companies and therefore needs to be considered as well. This further argues for the need for a RL-system as well as selling the reused product for the same price as a new product.

As some architects, ceiling installation companies and demolition companies do not believe reuse is appropriate for all types of products, especially acoustic ceilings, and since interviewees also mention the design phase of products as an important phase for reuse, the need for *designing products for reuse* is evident as well. Therefore the circular design strategies for products, mentioned in chapter 3.2.1, is a need. Interviewees also meant disassembly and retained functional properties raised concerns regarding reuse and thus designing for reliability and durability as well as designing for disassembly and reassembly are the most important design factors.

Even though the main adversaries, such as installers and demolition companies, have a low project influence in general, as discussed in chapter 5.2, there is a need to incentivise reuse practices for ceiling installation companies and demolition companies through *feedback receptiveness*, to enable further adoption of the concept. It is therefore important to find stakeholders of this type that have a personal interest and drive during early adoption of reuse as they would become change agents and further help describe what incentives are needed by using

an iterative process seen in figure 16 in chapter 3.5. This is a need since reuse practices are not fully adopted within these two businesses today and new incentives might be needed. An iterative process should, however, be used for all decisions made for the innovation around reuse, to make sure new understandings keep occurring.

## 5.6 Industry gaps

As mentioned in chapter 5.4, the industry silo mentality has led to different opinions on what aspects are connected to reuse and thus created gaps. But there are also gaps concerning different perceptions and knowledge.

The first identified gap is what *assurances are relevant* for reuse. Most of the interviewed stakeholders referred to quality assurances, but there are still some who believed warranties are needed to purchase reused construction products, and more specifically reused acoustic ceilings. Some interviewees also believed no assurances would be needed or would be impossible to give. These gaps appear both internally as well as in the planning and implementation phase. For example, real estate companies were convinced a quality assurance would be enough, while GC companies would like warranties as well.

*Perceptions on what price* a reused acoustic ceiling could be sold or bought for were also split. Internally, a lower price, higher price and the same price were all mentioned, with a majority believing in the same price. However, for the planning phase stakeholders, a large majority would purchase a reused acoustic ceiling for the same price as the virgin product, while most of the implementation phase stakeholders believed the price either did not matter or it should be sold for a lower price.

There were also gaps in *theoretical knowledge* on circular economy and reuse. Interviewees were asked to differentiate between terms described in the 9R framework, seen in figure 5 in chapter 3.1.2, and while a majority could differentiate the terms in a practical sense, some could not differentiate the terms at all, especially for reuse compared to refurbishment, which was often referred to as synonyms during interviews. The groups within the external

planning phase showed limited knowledge especially compared to the other stakeholder groups. Most of the external planning phase stakeholders had a clear view of the differences between the terms and could even refer to the waste hierarchy when explaining differences. Internally the differences between reuse and recycling could be explained by all interviewees in a practical sense but reuse and refurbishment were, once again, harder to differentiate. Believing a reused and refurbished product have the same value can create problems for customer expectations and perceptions of price, which is why the importance of education and knowledge as well as transparency in marketing needs to be highlighted to ensure the customer understands what they are paying for.

As mentioned in chapter 5.2, the interest in courses given by manufacturers was high. However, there were different opinions on how these *courses should be designed* and it is also not possible to say what the majority believed in since the opinions were very split. Some interviewees thought courses should be held in a general sense regarding reuse, while others wanted the courses to be either product or project specific, arguing the manufacturer knows their own product best and not the entire theory around reuse. Demolition contractors showed no interest in courses, but they should be educated in how to disassemble to be able to fulfil the second condition mentioned in chapter 4.5.

Regarding *influence on the choice of materials*, there is a gap between what the internal stakeholders believed and what the external stakeholder perceived. Internally a majority believed the installation companies have the highest influence on the choice of materials since they have the option to switch prescribed materials for e.g. cheaper or lighter materials. However, all the external stakeholders meant either the end-client or the real estate company have the highest influence on materials. From interviews with ceiling installation companies, it was also discovered swapping out material from architects' prescriptions was not as common and always a discussion between the parties involved.





## 6 Proposition & Conclusions

*In this chapter the recommendations to the case company, connection to research questions, contributions and future work are presented to conclude the work of this thesis. The recommendations conclude a best practice from the perspectives of the offer, a short term focus and a long term focus.*

### 6.1 Recommendations

#### 6.1.1 Case company-specific recommendations

The recommendations to the case company are generated from the DIBN-framework seen in figure 17 in chapter 5.1. Thus, the resulting offer, short term focus and long term focus can be seen in figure 18.

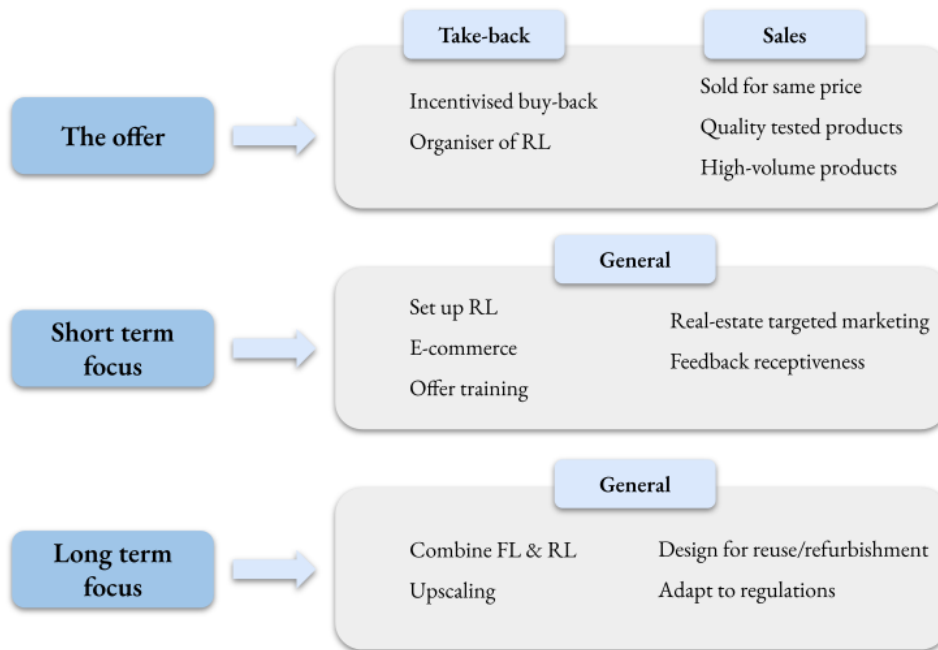


Figure 18: Case company-specific recommendations from DIBN, own work

*The offer* can be divided into a *take-back offer*, which is how the RL-system should be designed, and a *sales offer*, which is the prerequisite for how the reused acoustic ceilings should be sold. The short term and long term focus have general focus areas. All these recommendations shall help the case company move forward with a market for reuse.

### **6.1.2 The general offer**

#### **Take-back**

The take-back offer includes an *incentivised buy-back* for the material owner, i.e. demolition company or real estate company, as well as the case company becoming the *organiser of a RL-system*.

Incentivising the buy-back of reused acoustic ceilings should be done through economics and a simplicity perspective. The economics perspective includes paying for the service of deconstruction and for the acquisition of acoustic ceilings to be reused, such as the material costs and shipping and handling costs. Independent of who has the ownership of the material, both these are needed. Since if the demolition company has total ownership of materials in a selective demolition project, the extra time it takes to deconstruct acoustic ceilings needs to be covered financially by the case company and the materials need to be paid for as well, to make sure the demolition company sees the economic demand, as discussed in chapter 4.5, and therefore the demolition company does not consider selling the product on a second-hand construction market. Since simplicity is an important factor for demolition companies, this buy-back solution would be an attractive offer. This methodology incentivises the buy-back from real estate companies as well, since this would eliminate the storage costs for real estate companies' reuse-hubs and cover the added labour costs for deconstruction work.

The case company should also be the organiser of the RL-system which would give more control to the case company while making it simpler for the stakeholders involved. As demanded by the stakeholders, the RL-system should include a pick-up of demounted acoustic ceilings and should also provide

on-site packaging solutions for the demolition companies. This should be enabled through door-to-door pick-up and internet-based solutions, as discussed in chapter 3.2.3, since this would offer the most simple solution for the demolition company and would not cause any major changes to the traditional way of working in demolition.

## **Sales**

The sales offer includes acoustic ceilings be *sold for the same price* as a virgin product, *quality testing* of returned acoustics ceilings and applying reuse to *high-volume products only* at the beginning of the sales offer.

From the interviews with stakeholders, it was evident a majority would pay the same price for a reused acoustic ceiling compared to a virgin acoustic ceiling and this was also seen as a driver for reuse, reducing the risk of cannibalisation of products.

Even though there were gaps in assurances, most stakeholders believed quality testing was necessary, but not warranties. The quality of the products was also seen as an order winner, making quality the most important aspect when purchasing reused acoustic ceilings therefore quality testing must be included in the offer. Parameters to be considered when quality testing was discovered in the interviews to be: proof of climate impact, proof of non-hazardous substances and proof of retained functions and properties. Hence, this is what should be included in the quality testing of reused acoustic ceilings.

To easier create an in-house standard for reuse, reuse should be applied to *high-volume products only* in the beginning, thus turning *Lack of standardisation*, described as an inbetween in chapter 5.3, into a driver, setting a standard for reuse and creating a market opportunity. This would also guarantee unnecessary storage costs of slow-moving products are avoided and simplify the work of reuse packaging since the same measurements of packaging would be used for all products.

### 6.1.3 Short term focus

The short term focuses are determined by what is deemed as instant needs to enable the market for reuse.

As the case company should be the organiser of an RL-system, the *RL needs to be set up*. To establish the RL-system, as discussed in chapter 5.5, the process should follow the steps in figure 9. When determining the RL goals and strategy it is important to capture the customer value and keep in mind what the order winners and order qualifiers are, such as quality of products as an order winner and simplicity for the customer as an order qualifier. The credit rules should be set to make sure the quality requirements are fulfilled and meet gatekeeping goals, but should not be too restrictive to ensure the demolition companies do not view the deconstruction as high-risk work. When developing the RL-network and flow option, RL should be a stand-alone network for the short term as the focus should be to set up a simple working RL-system where experimenting can be done. The RL-system needs to be tracked to receive a view of what works and what does not. To enable this, KPI:s are needed and the relevant ones are KPI:s with the aspects: financial, environmental, social, operational and management, mentioned in chapter 3.2.3. Since it was also mentioned proof of climate impact, proof of non-hazardous substances and proof of retained functions and properties were needed and should be included in the offer, products need to be traced in the supply chain to confirm the products resold meet the qualifications for the proofs and increase the visibility in the supply chain. The tracing of products would also decrease the manual inspection work needed to assure the correct high-volume products are returned.

An *e-commerce* solution was identified as a need to simplify the procurement process for customers. Therefore this should be a short term focus, where a customer portal should be created where customers can purchase products as well as offering another platform for the case company to spread information regarding reuse offers.

As discussed in chapter 5.5, there is a need to apply the circular marketing mix, seen in figure 8 for the reuse marketing. This marketing should *target the real estate companies* mainly since they have the highest influence on material

choice. Architects, who are promoters of reuse and prescribe materials, should also be included in the targeted marketing. The circular marketing mix highlights questions like tracing of supply chain and collection methods, strengthening the argument of setting up a well-functioning RL-system. The answers for the circular logistics-related questions in figure 8 can be used as a marketing tool to increase brand image and transparency towards the customers, thus creating trust between stakeholders as well. The RL-service should also be marketed to ensure demolition companies know it exists as well, in case of total ownership of materials for demolition companies in selective demolition projects. Along with the circular marketing mix, the focus should lie in how reusing acoustic ceilings have an impact on GBC:s. It should therefore be made clear to the real estate company in which way reusing acoustic ceilings help contribute towards certain credits in GBC:s.

*Courses and educational training* was seen as a driver for reuse but there were gaps regarding course designs, as discussed in chapter 5. It was also highlighted in chapter 4.5 how demolition companies need to distinguish appropriate routines to disassemble for reuse to be in place. Therefore, as a short term focus, different training groups should be set up where different stakeholders are educated in different ways. Demolition companies need to be educated in a practical sense on how to demount acoustic ceilings properly, to avoid damaging of ceiling tiles during deconstruction. The planning phase stakeholders should be educated in a mix of general and product-specific levels. The general level is needed to make the planning phase stakeholders see the value in reusing acoustic ceilings and to spread awareness of reuse practices being an option at the case company. The product-specific level was insisted on by some interviewees as well, which would help the stakeholders understand how reuse of acoustic ceilings could be applied to a project. This would create an answer to both *how* and *why* reuse should be perceived as a new innovation relevant to the planning phase stakeholder's business.

The general courses can be held in a digital environment, while the product-specific courses should be held in person to easier show the stakeholder the practical work like dismounting of ceilings as well as being able to show the physical products. The first inspection of the ceilings are done on-site and

therefore the product courses should include a session to show how acceptable returnable products look and feel and has to be done in person.

It was also discussed in chapter 5.5 how *feedback receptiveness* is important and that the iterative process, seen in figure 16 in chapter 3.5, should be used to increase collective wisdom for the market for reuse innovation. However, it is important to verify problems are focused when collecting wisdom, since the crowd is generally bad at handling open-ended discussions and this in turn could lead to the wrong decisions in regard to set goals.

#### **6.1.4 Long term focus**

The long term focuses are determined by what should be continuously worked on to enable long term success for the reuse of acoustic ceilings business.

Once a well-functioning RL-system is set up, *RL and FL should be combined* into a holistic logistical system to optimise the logistical network and create an efficient and cost-effective distribution network, reducing the number of transports and also CO<sub>2</sub>-emissions from distribution. Therefore the distribution should also be considered to be turned into an in-house service, to gain more control over the logistics as well as not being limited by the capacity of third-party logistics providers.

In the long term, the reuse service also needs to be *scaled up*, both the capacity to meet the reuse market demand as well as the reuse product portfolio. As the construction industry is moving to become more circular it is relevant to assume the demand for reused products, such as reused acoustic ceilings, will increase, and this is also supported by the interviewees' beliefs that reuse is a trend that will continue being relevant in the future. This also means the product portfolio, of which products should be included in a reuse offer, should be extended as well, including more products to help create an even more circular construction industry.

Another way to help create an even more circular construction industry is looking into *refurbishment possibilities*. If it turns out a low amount of products meets the requirements set for acoustic ceilings deemed for reuse, refurbishment can be

an alternative circular strategy, following the 9R waste hierarchy in figure 5 in chapter 3.1.2 and making sure fewer products end up as landfill.

The acoustic ceilings should also be *designed for reuse* even further, as mentioned in chapter 5.5. This would create a longer lifespan of products and therefore also create greater availability of acoustic ceilings in use that could be reused in the future.

Lastly, it is important for the case company to be adaptable to changes in regulations that could affect the market for reuse. As has been discovered, there is an ongoing revision of the CPR where reuse is mentioned, and general standards for reusing construction products may appear. Adapting to new regulations for reuse would also remove customer uncertainty regarding future standardisation of reused products, thus removing *lack of standardisation*, discussed in chapter 5.3, from the inbetweeners completely.

## **6.2 Connection to research questions**

Looping back to research questions in chapter 1.3, it is possible to say that the driving forces that incentivise reuse of acoustic ceilings have been identified, presented and described, derived from the DIBN-framework, seen in figure 17 in chapter 5.1. The identified drivers are:

- Reuse as a trend
- High demand
- Course interest
- Adversary influence low
- Real estate influence high
- GBC:s
- CE-marking
- Sell for same price

Hence **RQ1** has been purposefully answered.

The barriers preventing reuse in the construction industry have also been established and can also be derived from the DIBN-framework. The identified barriers are:

- Inflexible industry
- Industry silo mentality
- Lack of economic incentives
- Low availability
- High product expectations
- Complex logistics

Hence **RQ2** has been purposefully answered as well.

With the aid of existing theory on circular economy, circular logistics, initiatives towards sustainable construction, GBC:s and management & behaviour aspects as well as empirics discovered through literature and interviews, it was possible to find and also describe a best practice for the case company, which can be seen in chapter 6.1. The recommendations form a baseline for how the case company should deliver a general offer for reuse and how they should work with the market for reuse in short term as well as in long term. Therefore, **RQ3** has been purposefully answered and this concludes the work for this thesis.

### **6.3 Contributions**

This research project has contributed to a deeper understanding of perceptions of reuse in the construction industry. Several connections between different factors affecting the concept of reuse have been identified using a literature review as well as qualitative interviews within the construction industry, creating an understanding of methods in circular economy that can be used to create market opportunities.



The DIBN-framework provided a contribution to the case company through identification of drivers and barriers. The DIBN-framework also shows gaps, needs and inbetweeners need to be evaluated as well when establishing a market for reuse. The DIBN-framework could also potentially be used by other manufacturers within the construction industry on establishing a reuse market for construction products. A *naked* DIBN-framework, without specific codes, could also be of value to the academics, forming a holistic baseline for market research.

Another contribution made to the case company was also the establishment of a best practice for working with reuse from a market perspective as a ceilings manufacturer. The recommendations presented a holistic approach through a general offer, short term focus and long term focus, enabling success for the market for reuse.

#### **6.4 Future work**

As some aspects were left out of this research through delimitations and project scope, some discovered aspects during the research have intentionally been passed over to future work, such as outsourcing opportunities, Building Information Model, product-as-a-service, inventory management, warehousing and packaging. Some aspects concerning laws and CE-marking should be researched further in the future as well due to a lack of established rules regarding reuse to this present day.

Further research on outsourcing opportunities could be of relevance, discussing optimal outsourcing setups and cost-effectiveness. This also includes investigating what services should be outsourced and what should be done in-house, which would need a thorough cost analysis while also considering the alignment of company goals. It is also mentioned in chapter 3.2.3, tactical decisions regarding outsourcing RL to third-party logistics providers could be done to gain a competitive advantage.

How the Building Information Model and further digitalisation has an impact on reuse and circularity needs to be analysed in the future. This could be a relevant tool for tracking in the RL-system, which was discussed as a recommendation to

the case company in relation to optimising the RL-system.

Product-as-a-service was also discovered as a possible business model for reuse and should be investigated further due to the connection between circular economy and providing products as a service.

Options for inventory management and warehousing also need to be analysed in detail, due to the potential need for separate inventory management and warehousing of reused acoustic ceilings. Models for inventory management and warehousing of circular products [Kossila, 2022], could be used to optimise costs and service levels for customers.

Packaging should also be further researched to make the process of keeping returned products undamaged. It would create simplicity for both the demolition companies in selective demolition projects and the installation companies when receiving and installing the reused products. As the circular marketing mix in figure 8 in chapter 3.2.2 suggests, circular packaging should be investigated as a further contribution to circularity within the construction industry.

## References

- [Allen, 2017] Allen, M. (2017). *The sage encyclopedia of communication research methods*. SAGE Publications, Inc. <https://doi.org/10.4135/9781483381411>. Accessed on 2023-03-22.
- [Birkinshaw, 2012] Birkinshaw, J. (2012). *Reinventing Management: Smarter Choices for Getting Work Done*. John Wiley & Sons Inc.
- [Boverket, 2023a] Boverket (2023a). About boverket. <https://www.boverket.se/en/start/about/about-boverket/>. Accessed on 2023-04-26.
- [Boverket, 2023b] Boverket (2023b). Internationellt arbete. <https://www.boverket.se/sv/om-boverket/boverkets-uppdrag/internationellt-arbete/>. Accessed on 2023-04-26.
- [Boverket, 2023c] Boverket (2023c). Voluntary environmental certification. <https://www.boverket.se/en/start/building-in-sweden/developer/rfq-documentation/climate-declaration/environmental-certification/>. Accessed on 2023-02-22.
- [Bryman and Bell, 2015] Bryman, A. and Bell, E. (2015). *Företagsekonomiska forskningsmetoder*. Liber.
- [Chen and Cotter, 2021] Chen, H. and Cotter, L. (2021). Reverse Logistics: What It Is and Where It Is Headed. In *The Oxford Handbook of Supply Chain Management*. Oxford University Press.
- [Circle Economy, 2022] Circle Economy (2022). The circularity gap report sweden. Technical Report version 2.0.
- [Ding et al., 2023] Ding, L., Wang, T., and Chan, P. W. (2023). Forward and reverse logistics for circular economy in construction: A systematic literature review. *Journal of Cleaner Production*, 388:135981.
- [Ecophon, 2023a] Ecophon (2023a). About ecophon. <https://www.ecophon.com/uk/about-ecophon/>. Accessed on 2023-01-19.

- [Ecophon, 2023b] Ecophon (2023b). Sustainability we can all believe in. <https://www.ecophon.com/uk/about-ecophon/sustainability-we-can-all-believe-in/>. Accessed on 2023-01-19.
- [Ellen MacArthur Foundation, 2019] Ellen MacArthur Foundation (2019). Circular economy diagram. <https://ellenmacarthurfoundation.org/circular-economy-diagram>. Accessed on 2023-02-15.
- [Ellen MacArthur Foundation, 2023a] Ellen MacArthur Foundation (2023a). Circular economy introduction. <https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>. Accessed on 2023-02-13.
- [Ellen MacArthur Foundation, 2023b] Ellen MacArthur Foundation (2023b). Circulate products and materials. <https://ellenmacarthurfoundation.org/circulate-products-and-materials>. Accessed on 2023-02-15.
- [Ellen MacArthur Foundation, 2023c] Ellen MacArthur Foundation (2023c). Eliminate waste and pollution. <https://ellenmacarthurfoundation.org/eliminate-waste-and-pollution>. Accessed on 2023-02-15.
- [Ellen MacArthur Foundation, 2023d] Ellen MacArthur Foundation (2023d). Regenerate nature. <https://ellenmacarthurfoundation.org/regenerate-nature>. Accessed on 2023-02-17.
- [EPD International, 2023] EPD International (2023). What is an ..... e ..... p ..... d ..... (morse?). <https://www.environdec.com/all-about-epds/the-epd>. Accessed on 2023-04-26.
- [European Commission, 2015] European Commission (2015). *EUROPEAN COMMISSION CE MARKING OF CONSTRUCTION PRODUCTS STEP BY STEP*.
- [European Commission, 2022] European Commission (2022). Proposal for a regulation of the european parliament and of the council laying down harmonised conditions for the marketing of construction products, amending regulation (eu) 2019/1020 and repealing regulation

- (eu) 305/2011. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022PC0144&from=EN>. Accessed on 2023-02-13.
- [European Commission, 2023a] European Commission (2023a). Circular economy action plan. [https://environment.ec.europa.eu/strategy/circular-economy-action-plan\\_en](https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en). Accessed on 2023-02-13.
- [European Commission, 2023b] European Commission (2023b). Eu:s gröna giv. [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal\\_sv](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_sv). Accessed on 2023-03-16.
- [Höst et al., 2006] Höst, M., Regnell, B., and Runeson, P. (2006). *Att genomföra examensarbete*. Studentlitteratur.
- [Kirchherr et al., 2017] Kirchherr, J., Reike, D., and Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127:221–232.
- [Kossila, 2022] Kossila, L. (2022). *Circular Logistics in the Nordics*. Studentlitteratur.
- [Kovács and Spens, 2005] Kovács, G. and Spens, K. M. (2005). Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics Management*, vol. 35,(no. 2):pp. 132–144.
- [Kovács and Spens, 2007] Kovács, G. and Spens, K. M. (2007). Logistics theory building. *The Icfai Journal of Supply Chain Management*, vol. IV,(no. 4):pp. 7–21.
- [LEED, 2023a] LEED (2023a). Leed rating system. <https://www.usgbc.org/leed>. Accessed on 2023-02-22.
- [LEED, 2023b] LEED (2023b). Leed scorecard. <https://www.usgbc.org/leed-tools/scorecard>. Accessed on 2023-02-22.
- [Mallick et al., 2023] Mallick, P. K., Salling, K. B., Pigosso, D. C., and McAloone, T. C. (2023). Closing the loop: Establishing reverse logistics for a circular economy, a systematic review. *Journal of Environmental Management*, 328:117017.

- [Nobre and Tavares, 2021] Nobre, G. C. and Tavares, E. (2021). The quest for a circular economy final definition: A scientific perspective. *Journal of Cleaner Production*, vol. 314.
- [Potting et al., 2017] Potting, J., Hekkert, M., Worrell, E., and Hanemaaijer, A. (2017). Circular economy: Measuring innovation in the product chain. *PBL Netherlands Environmental Assessment Agency*, vol. 2544.
- [Regeringskansliet, 2022] Regeringskansliet (2022). Revidering av byggproduktförordningen 2021/22:fpm82. <https://data.riksdagen.se/fil/419171EF-97BF-4026-B01E-08C1438386B6>. Accessed on 2023-04-19.
- [Safeopedia, 2017] Safeopedia (2017). Reuse. <https://www.safeopedia.com/definition/2353/reuse>. Accessed on 2023-01-19.
- [SBAB, 2021] SBAB (2021). Bankgemensamt initiativ för en mer hållbar byggbransch. [https://www.sbab.se/1/om\\_sbab/press/arkiv\\_publicering/pressmeddelande/2021-04-14\\_bankgemensamt\\_initiativ\\_fo\\_r\\_en\\_mer\\_hallbar\\_byggbransch.html](https://www.sbab.se/1/om_sbab/press/arkiv_publicering/pressmeddelande/2021-04-14_bankgemensamt_initiativ_fo_r_en_mer_hallbar_byggbransch.html). Accessed on 2023-04-20.
- [Segal, 2022] Segal, T. (2022). Green bond: Types, how to buy, and faqs. <https://www.investopedia.com/terms/g/green-bond.asp>. Accessed on 2023-04-20.
- [SGBC & BRE Global, 2023] SGBC & BRE Global (2023). *BREEAM-SE New Construction v6.0 - Technical Manual 1.1*.
- [Swedbank, 2021] Swedbank (2021). Hållbar fastighetsfinansiering – från byggstart till färdig bostad. <https://news.cision.com/se/swedbank/r/hallbar-fastighetsfinansiering---fran-byggstart-till-fardig-bostad,c3281869>. Accessed on 2023-04-20.
- [Sweden Green Building Council, 2022] Sweden Green Building Council (2022). *Miljöbyggnad 4.0 User Guide*.
- [Swedish Green Building Council, 2023a] Swedish Green Building Council (2023a). Breeam se. <https://www.sgbc.se/certifiering/breeam-se/>. Accessed on 2023-03-03.

- [Swedish Green Building Council, 2023b] Swedish Green Building Council (2023b). Certifierade projekt. <https://www.sgbc.se/statistik/>. Accessed on 2023-04-25.
- [Swedish Green Building Council, 2023c] Swedish Green Building Council (2023c). Vad är leed? <https://www.sgbc.se/certifiering/leed/vad-ar-leed/>. Accessed on 2023-02-22.
- [UNEP, 2023] UNEP (2023). Reuse. <https://buildingcircularity.org/reuse/#stories>. Accessed on 2023-01-19.
- [United Nations, 2023] United Nations (2023). The 17 goals. <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>. Accessed on 2023-03-02.
- [Van Buren et al., 2016] Van Buren, N., Demmers, M., Van der Heijden, R., and Witlox, F. (2016). Towards a circular economy: The role of dutch logistics industries and governments. *Sustainability*, 8(7).
- [van den Berg et al., 2020] van den Berg, M., Voordijk, H., and Adriaanse, A. (2020). Recovering building elements for reuse (or not) – ethnographic insights into selective demolition practices. *Journal of Cleaner Production*, 256:120332.
- [Wilson and Goffnett, 2022] Wilson, M. and Goffnett, S. (2022). Reverse logistics: Understanding end-of-life product management. *Business Horizons*, 65(5):643–655.
- [Yin, 2014] Yin, K., R. (2014). *Case Study Research: Design and Methods: Fifth edition*. SAGE Publications, Inc.





# Appendices

## Appendix A: List of interviewees

Table 2: List of interviewees

Interviewee number	Role/Company title	Company type	Internal/External
1	Area Sales Manager	Case company	Internal
2	Technical Support/Sustainability Expert	Case company	Internal
3	Area Sales Manager	Case company	Internal
4	Area Sales Manager	Case company	Internal
5	Project Manager	Real estate	External
6	Marketing Manager	Case company	Internal
7	Sustainability Manager	Real estate	External
8	PhD Architect	Architecture firm	External
9	Project Manager	Project consultants	External
10	Business Support and Development	General contracting	External
11	Project Manager	General contracting	External
12	CEO	Real estate	External
13	Joint owner/CEO	Ceiling installation	External
14	Intern	Real estate	External
15	Joint owner	Demolition	External
16	Architect/Partner	Architecture firm	External
17	Sustainability Coordinator	Real estate	External
18	Owner	Demolition	External
19	Joint owner	Ceiling installation	External

## Appendix B: Interview guide: Internal stakeholders

### Context

*Introduce ourselves and the topic and why we are doing this study. Explain we are open to any questions regarding the thesis. Participating in this interview is voluntary and you can withdraw at any time. Your name will be anonymised. The interview will take 45-60 minutes.*

- Can we use your role in your company for our report?

### Introductory questions

*Background information is gathered, and warm-up questions are asked to make the interviewee feel comfortable talking to us.*

- Can you tell us a bit about yourself and what you do for work?
- What is your position at the company?
- How long have you worked as a [position]?

### Filter questions

*Questions to make sure the interviewee contacted matches the description of who we want to interview.*

- Have you previously worked with or are working with sales or marketing within the construction industry?

### Main questions

*Questions relevant for our thesis that will either give insights or answers on discussed topics.*

### Internal business unit related questions

- What do you believe are the key trends when it comes to sustainability in the construction industry?
- What is your general opinion on the concept of reuse?
  - Reuse on the acoustic ceiling business?
- What would you say are the differences and similarities between reuse and recycling?
- What would you say are the differences and similarities between reuse and refurbishment?
- Have you ever taken any internal course or training concerning sustainability and circular economy?
  - If yes, what was discussed during these training sessions?

## **Appendix B: Interview guide: Internal stakeholders**

- If not, do you believe your department would benefit/drawback from implementing this?
- Would you feel comfortable promoting reuse as part of the company's marketing strategy?
  - If not, why not?
- Do you believe European regulations concerning circular economy are a barrier or a driver towards selling reused ceilings?

### Customer-centered questions

- Which customers do you perceive as having the biggest influence on a sale? (i.e., architects, contractors, installers, building owners, end-user)
  - Why is that?
- How much demand is there today for reused ceilings?
  - Who are the customers asking for reuse and what is the estimated market size for these?
  - Why do they ask for reuse?
  - What do they specifically ask for concerning reuse?
- Do you believe reused ceilings could be sold for a higher, lower or the same price as a new ceiling?
- Do you believe any assurances are necessary to convince the customer to purchase reused ceilings? (i.e., guarantees, warranties, markings, labels, performance tests)
- What is your opinion on the knowledge customers have on circular economy? (i.e., good, bad)
  - On reuse in particular?
- Which marketing channels would you say are most suitable for the concept of reuse?
- Do you have any ideas on how to make reuse a more widely adopted concept in the construction industry, enabling a higher number of sales? (i.e., raising awareness of environmental impacts etc.?)
- What do you think the market will look like in the future, related to circular economy? (i.e., 2-5 years from now?)
- What would you like your business to look like in the future? (i.e., services proud to provide)

## **Appendix B: Interview guide: Internal stakeholders**

- Do you believe trends related to circular economy will still be relevant in the future?
  - Why/Why not?

### Summary

*Thank the interviewee for their time and ask them if they have anything they want to add. Explain that the information gathered from the interview will be used as part of the empirics in the master thesis project and the final report will be published at the Division of Production Management at LTH.*

- Is there anything you would like to add or was unclear?

## Appendix C: Interview guide: Planning phase

### Context

*Introduce ourselves and the topic and why we are doing this study. Explain we are open to any questions regarding the thesis. Participating in this interview is voluntary and you can withdraw at any time. Your name will be anonymised. The interview will take approximately 45-60 minutes.*

- Can we use your role in your company for our report?

### Introductory questions

*Questions to make the interviewee feel comfortable talking to us.*

- Can you tell us a bit about yourself and what you do for work?
- What is your position at the company?
- How long have you worked as a [position]?

### Filter questions

*Questions to make sure the interviewee contacted matches the description of who we want to interview.*

- Have you previously worked with or are working as a... (architecture, demolition, building owner, project leader, reuse, etc. – depends on the interviewee) within the construction industry?

### Main questions

*Questions relevant for our thesis that will either give insights or answers on discussed topics.*

#### Questions on knowledge of circular economy

- What do you believe are the key trends when it comes to sustainability in the construction industry?
- Do you believe trends related to circular economy will still be relevant in the future?
  - Why/Why not?
- Do you think there is a market for construction materials/components reuse in Sweden?
  - If yes, for what type of construction materials/components?
  - If not, why?

## Appendix C: Interview guide: Planning phase

- Is there a market for reused acoustic ceiling tiles?
- What would you say are the differences and similarities between reuse and recycling?
- What would you say are the differences and similarities between reuse and refurbishment?
- Have you ever taken a course or attended any training on sustainability? (e.g., circular economy or reuse)
  - If yes, who decided this?
  - If not, do you believe your department at your company would benefit/drawback from this?
  - Would you be interested in courses given by a manufacturer?
- What is your general opinion on reuse?
  - Reuse in the acoustic ceiling business?

### Questions on reuse practices

- Have you been a part of a project that used or is using reused materials?
  - What materials were reused?
  - What was the reason for using reused materials?
  - What were the biggest challenges that you encountered during the project concerning reuse?
  - Was the project designed or planned for deconstruction or disassembly?
- How much influence do you as a [position] have on choice of materials in a new project?
- How would you go about buying reused building materials? (Question about the platform to use)
- Is reuse always considered as an option for a new project?
  - What is usually the deciding factor on whether reused or new materials are used?
- Which are the three most important aspects when purchasing reused materials or products?
  - Which would you say is the least and most important out of the three mentioned aspects?
  - Are there any more aspects than these three you find important?

## Appendix C: Interview guide: Planning phase

- What assurances would you say are necessary for you to buy a reused ceiling from Ecophon? (i.e., guarantees, warranties, labels, markings, others)
  - If these assurances are not in place, how comfortable would you feel buying reused acoustic ceilings compared to new ones?
  - If these assurances are in place, how comfortable would you feel buying reused acoustic ceilings compared to new ones?
  - (If reuse has been part of a previous project): What assurances were in place for the last project?
- What role do certifications (e.g. LEED, Miljöbyggnad, BREEAM-SE and GreenBuilding) have when planning a new project?
  - Would you consider building more sustainable even if there were no certifications to be awarded?
- How important is the price when purchasing a reused acoustic ceiling?
  - If you would purchase a reused acoustic ceiling, would you pay more, less or the same price as a new ceiling?
  - If no assurances are in place, how would this affect the price you would pay?

### Questions concerning drivers and barriers for reuse

- What are the main drivers in implementing circular strategies (like reuse) in a construction project? (i.e., labels, certifications, PR, sustainable thinking, customer demand etc.)
- What are the main barriers in implementing circular strategies (like reuse) in a construction project? (i.e., lack of interest, costs, company cultures, logistical barriers, time)
- What part of the process creates the biggest obstacle for reusing ceilings?
- What effect/effects do/does local or European regulations have on the concept of reuse, according to your belief?
- Who guides or determines whether or not you should adopt circular strategies (like reuse) in a new project? (i.e., architects, building owners, contractors)
- In what way could circular design strategies impact the design process of a new project?

## **Appendix C: Interview guide: Planning phase**

- Do you have any ideas on how to make reuse a more widely adopted concept in the construction industry? (i.e., raising awareness of environmental impacts)
- What do you believe would be the dream service?

### Summary

*Thank the interviewee for their time and ask them if they have anything they want to add. The information gathered from the interview will be used as part of the empirics in the master thesis project and the final report will be published at the Division of Production Management at LTH.*

- Is there anything you would like to add or was unclear?



## Appendix D: Interview guide: Implementation phase

### Context

*Introduce ourselves and the topic and why we are doing this study. We are open to any questions regarding the thesis. Participating in this interview is voluntary and you can withdraw at any time. The interview will take approximately 45-60 minutes.*

- Can we use your role in your company for our report?

### Introductory questions

*Questions to make the interviewee feel comfortable talking to us.*

- Can you tell us a bit about yourself and what you do for work?
- What is your position at the company?
- How long have you worked as a [position]?

### Filter questions

*Questions to make sure the interviewee contacted matches the description of who we want to interview.*

- Have you previously worked with or are working in demolition or installing or both within the construction industry?

### Main questions

*Questions relevant for our thesis that will either give insights or answers on discussed topics.*

#### Questions on knowledge of circular economy

- What do you believe are the key trends when it comes to sustainability in the construction industry?
- Do you believe trends related to circular economy will still be relevant in the future?
  - Why/Why not?
- Do you think there is a market for construction materials/components reuse in Sweden?
  - If yes, for what type of construction materials/components?
  - If not, why?
  - Is there a market for reused acoustic ceiling tiles?
- What would you say are the differences and similarities between reuse and recycling?

## Appendix D: Interview guide: Implementation phase

- What would you say are the differences and similarities between reuse and refurbishment?
- Have you ever taken a course or attended any training on sustainability? (e.g., circular economy or reuse)
  - If yes, who decided this?
  - If not, do you believe your department at your company would benefit/drawback from this?
- What is your general opinion on reuse?
  - Reuse on the acoustic ceiling business?

### Questions on reuse practices (for installers)

- Have you been a part of a project that used or is using reused materials?
  - What materials were reused?
  - What was the reason for using reused materials?
  - What were the biggest challenges that you encountered during the project concerning reuse?
- How much influence do you as a [position] have on choice of materials in a new project?
  - To what extent can prescribed materials be changed?
  - What would be the reason for you to pick another product than the example materials described in prescriptions?
  - Who guides or determines whether or not you should adopt circular strategies (like reuse) in a new project? (i.e., architects, building owners, contractors)
- How would you go about buying reused building materials today? (Question about the platform to use)
  - How would you wish the process of buying reused materials would look like?
- Is reuse always considered as an option for a new project?
- Which are the three most important aspects when purchasing reused materials or products?
  - Which would you say is the least and most important out of the three mentioned aspects?
  - Are there any more aspects than these three you find important?

## Appendix D: Interview guide: Implementation phase

- What assurances would you say are necessary for you to buy a reused ceiling from Ecophon? (i.e., guarantees, warranties, labels, markings, others)
  - If these assurances are not in place, how comfortable would you feel buying reused acoustic ceilings compared to new ones?
  - If these assurances are in place, how comfortable would you feel buying reused acoustic ceilings compared to new ones?
  - (If reuse has been part of a previous project): What assurances were in place for the last project?
- How important is the price when purchasing a reused acoustic ceiling?
  - If you would purchase a reused acoustic ceiling, would you pay more, less or the same price as a new ceiling?
  - How does assurances from a manufacturer affect the price you would pay?

### Questions on deconstruction practices (for demolitionists)

- Have you ever been part of a selective demolition project?
  - What materials were salvaged/destroyed? Why?
  - What happened to the salvaged materials?
  - Why was the project planned this way?
  - What were the biggest challenges that you encountered during this project?
  - If not: Why have you never been part of such a project?
- How much influence do you as a [position] have when planning for a selective demolition?
  - Who has the biggest influence?
- What incentives are needed for you to always consider/agree to selective demolition for a project?
- How would you like the return service to be like in case you have material on hand at its end of life?

### Questions concerning drivers and barriers for reuse

- What are your expectations on reuse within the construction industry?
- What are the main barriers in implementing circular strategies (like reuse) in a construction project? (i.e., lack of interest, costs, company cultures, logistical barriers, time)

## **Appendix D: Interview guide: Implementation phase**

- What part of the process creates the biggest obstacle for reusing ceilings?
- What effect/effects do/does local or European regulations have on the concept of reuse?
- Do you have any ideas on how to make reuse a more widely adopted concept in the construction industry? (i.e., raising awareness of environmental impacts)
- What do you believe would be the dream service?

### **Summary**

*Thank the interviewee for their time and ask them if they have anything they want to add. Explain that the information gathered from the interview will be used as part of the empirics in the master thesis project and the final report will be published at the Division of Production Management at LTH.*

- Is there anything you would like to add or was unclear?