From Linear to Circular: Circular Economy in the Danish Construction Industry

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Abstract:

This thesis is a study of the current status, and potential Circular Economy, in the Danish construction industry, and the gap between the two. Through interviews with, and analyses of, a sample of nine companies, an understanding of the industry is established. A scale is developed to evaluate the circularity of processes of the individual companies. It is established that implementing circular economy is associated with, mainly, three areas: Motivating the companies to take action, strengthening communication, and, finally, implementing circular processes, which will create a more circular industry. As a result, the focus of the thesis is the improvement of the communication in, and among, companies. Communication-focused suggestions are presented to the involved companies, as this is essential to the successful implementation of circular processes and methods. In conclusion, through the implementation of smaller steps towards circularity, within the individual companies, the industry can become more circular overall, as true circularity requires an industrywide collaboration.

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Preface

This project has been carried out within the Aalborg University Construction Management and Building Informatics Master's degree programme, by a team formed by a student from the Construction Management specialisation, and a student from the Building Informatics specialisation. The thesis aims to show the results and insights obtained throughout the semester. It has been written in the period comprised between the 2nd of September, 2019 and the 10th of January, 2020.

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Chapter 1

Introduction

There is a problem with the way the world consumes; last year, 2019, the Earth Overshoot Day, meaning the day on which the natural resources for the year were exhausted, was July 29th. Resulting in a use of resources which was 1.75 times faster than that which the Earth can regenerate, a trend which has been increasing for the last 30 years [41]. The linear model of take, make and dispose, which is the basis for most industries, is a large part of this problem as it accelerates the use of natural resources. The construction industry is one of these linear industries. It is responsible for more than 35% of the total waste produced in Denmark, 40% of the raw material usage in the EU, and 40% of the energy consumption in the EU [17] [33].

A concept which addresses these issues, by focusing on how materials can be circulated back into the processes replacing part of the need for raw materials is *circular economy*. With the implementation of circular economy in the construction industry, the large waste production, overconsumption of raw materials and high energy usage can be reduced, providing a positive development in the sustainability of, not only the industry, but the international environment.

With an understanding of the current status of the Danish construction industry in regards to the implementation of circular processes, established through interviews with companies involved in the sector, the gap between this, and a circular industry can be identified. The focus of this thesis is to bridge this gap, between the current situation in the construction industry and a more circular future. This issue will be addressed by looking into the processes which can be implemented within companies, and focus will be on creating a solution which fulfills the industry requirements. The aim is that companies will be able to take steps, leading the way to a circular construction industry. An industry which, as of now, has failed to successfully implement such advancements, therefore stagnating the circularity of the industry.

1.1 Problem Statement

The issues described in the introduction, create the basis for the need and aim of this thesis. A problem formulation has been developed to aim the research and development of the thesis within this area.

How can the industry, through focusing on improving company processes, yield a higher level of circularity?

- What is the current status of the industry, regarding circular economy?
- What are the main issues hindering circular economy, within processes, in the industry?
- What approaches can be taken to aid the company specific issues?
- How can the involved companies feasibly develop internal circular processes to yield better outcomes?

The problem formulation, with its sub questions, is developed in order to focus the scope of the thesis. Additional considerations regarding the scope and limits of the project are outlined in the following suchapter.

1.2 Limitations and Assumptions

For the development of this thesis a number of limitations and assumptions are made. These are made in order to limit the scope and to focus the direction of the project.

Firstly, it must be noted that a sample size of nine companies has been used in the thesis as a representation of the industry as a whole. This is nowhere near the lower limit of a traditional representative sample. This limit is due to resource and time constraints on the project. For a project of larger scope, and with additional resources, a much larger collection of companies will be necessary in order to represent the industry more adequately.

It is also important to note that within the time assigned for the study, it is not possible to study each company in sufficient depth to provide individual implementation plans. Therefore, it is possible, that if a company is studied in more depth, utilising similar methods, more suggestions can be found as well as offering a plan for the company to embrace such changes.

The basis of the thesis is in the current status of the industry, therefore, with the change of times, and the development of new processes and methods, changes will have to be considered.

The focus of the thesis is only on the processes which are within the companies.

This means that many aspects of circularity are purposefully left out of the thesis work. This has been done in order to limit the scope of the thesis, as a lack of research of circular processes in the industry was established, in the initial research. Additionally, the focus on the internal work of the companies means that aspects which need governmental, or other public, interference, are not included in the scope of the project.

1.3 Project Outline

In this subchapter an outline of the thesis is established. Here an understanding of what the aim of each chapter within the thesis can be found. Firstly, in *Chapter 2* the method used in the development of the thesis is outlined, in order to establish the validity and reliability of the conclusions drawn in the end. In *Chapter 3* circular economy is defined. This is done in order to determine the ultimate circular situation, the attainable circularity and, finally, the definition of circular economy applied in the project. In *Chapter 4* the current status of the Danish construction industry is established in order to identify the gap between this and a circular industry.

With a firm basis in the theory outlined until this point, the first round of interviews is conducted. In *Chapter 5* these are developed and analysed, creating a better understanding of the involved companies and the issues in the industry when considering the implementation of circular models. The next round of interviews is developed on the basis of this analysis, and the resulting interviews are used to delve into the specific issues. Therefore, this is the start of an understanding of the solutions which could aid the companies and the industry. Furthermore, the development and analysis of these is done in *Chapter 6*. In *Chapter 7* the gathered data from the interviews and research is used to develop solutions which will aid the industry and then applying these to the individual companies. These applied solutions are suggested while taking into account the specific needs of these. Finally, *Chapter 8* addresses the general conclusion of the thesis based on the previous chapters.

Chapter 2

Methodology

In order to deliver a thesis which works towards bridging the gap between the current industry status and the circular ideal, and manages to offer feasible suggestions that lead to more circular processes, a solid method has to be designed and developed. Analyses of the problem, industry and companies have to be completed, as well as finding the interrelation of these elements. Therefore, this thesis encompasses a train of thought and practices which trail through several steps in order to meet the demand of this aim. Thus, a method which has a flexible structure and can be applied to other studies, and with a process which can be replicated with different samples, still achieving similar, satisfactory results, was devised. The form of inquiry and analysis designed, helps support an off-look at the research which allows for assumptions to be made within the scope of the project, and to verify the validity of such assumptions. Therefore, certain considerations are taken into account in order to create solutions with specific meaning and aim within the relevant area. While staying within the constraints of the industry and its stakeholders.

2.1 General Considerations

The assumption is that Circular Economy is a concept which requires companies to take a holistic approach, with a long-term strategy which considers company processes ranging from creation to disposing. Depending on the type of company, and their business, different measures can be taken, with the aid of tools, that optimise practices and diminish waste throughout. Although, it is difficult to conceptualise and visualise total circularity, within the frames of sustainability (social, economic or environmental), any nudge towards circularity should be beneficial for a company. The implementation of this concept, even though it has huge potential, has been widely disregarded by the construction industry due to feasibility and economic concerns.

The AEC industry still has the possibility to join the race towards circularity, but the approach with which this can be tackled requires further in-depth analysis of the different actors and stakeholders. New processes and tools will aid the implementation of this concept; it is a matter of thinking in systems and creating innovative business models that take advantage of the core practices of the business.

With the focus on the implementability of the solutions, the use of a pragmatic worldview during the research is the obvious choice, as it is directed towards finding a solution which works. The pragmatic view allows for a study of what is of value for the topic at hand, therefore yielding results which can bring about positive consequences within the value system [43]. Pragmatism is not committed to only one system of philosophy and reality, instead, there is room for a mixed methods research system. This approach offers a system which inquires from both qualitative and quantitative assumptions in the research, this means that a solution is found in what works at the time of the research within the delimitation [9], while still utilising previously proven methods, to satisfactory solutions.

2.2 Research Design

The research of this thesis is based on the need for, first, understanding the current state of the industry and the ideal of circular economy, in order to define the gap which needs to be bridged in accordance with the problem formulation. Based on this understanding, opportunities and suggestions as to what can be done to bridge the gap are derived from research and are further investigated. This means that the study is both deductive and inductive in nature, as the first step is the validation of the assumption that there is a significant gap between the current AEC industry and a circular model. Thereafter, in an inductive approach, an exploration of the industry, through interviews, has the purpose of observing and categorising the involved companies, and on this background produce generalisations about the industry. Based on these a theory for the current status of the industry is developed. This theory is the basis for suggestions made in regard to specific steps which could aid in bridging the gap towards circularity. Suggestions which will be presented to the companies involved [7].



Figure 2.1: Inductive and Deductive Process

The figure above shows the methodical process that is implemented during the development of the thesis. It shows how the thesis switches between the deductive and inductive methods in order to create valid results from the initial research. Thereafter, yielding suggestions for the interviewed companies, as a result.

The research strategy relies on qualitative data collection performed through the described interviews and literature review. The use of qualitative research has the purpose of exploring and understanding the positioning of individuals or groups to a social, or human, problem. This thesis focuses, as mentioned, on the issue of the position of circular economy within the industry. The research process will be completed by analysing emerging patterns from the data collected through the literature review and interviews. A summarised version of the information is completed in order to collect and understand the necessary data to develop a base-line. Here the individual areas of the AEC industry can be compared to an average of the sample. This is done, in order to show which areas are problematic and where further improvement is needed to achieve a greater degree of circularity, within the scope of the project. The validity of the study is achieved by basing the thesis on technical papers, and corroborating the found data through interviews with relevant actors. These interviews inquire into the internal processes of the companies, while still considering their views based on their location in the value chain. Furthermore, the trustworthiness of the information is assessed according to the dimensions of credibility (recordings during interviews), transferability (context in which the study was made), dependability (record of the research process), and confirmability (objectivity about the findings considering where they were sourced from). Additionally, authenticity is achieved by showing the standpoints and opinions of the interviewees, improving the understanding of the phenomena studied, and providing opportunities for those involved to develop their insights into their own situations. This is achieved by delivering a comprehensive thesis with observations and suggestions which can then be acted upon by the interviewed companies [9].

2.3 Data Collection

The collection of data frames the study, and creates the basis for any analyses made and, later, conclusions drawn in the project. Therefore the method of data collection must be considered carefully. The method and the considerations are described in the following subchapters.

2.3.1 Literature Review

The research of this thesis is centered around two main areas: circular economy and the AEC industry. The literature reviewed should provide an insight to the definitions, understandings and tools connected to circular economy, as well as the current status and practices of the Danish construction industry. The assumption for starting the research is that the Danish AEC industry is not, currently, very circular. Therefore the first step of the literature research has the purpose to validate, or disprove, this assumption and identify the gap between the current status of the industry and the ideal circular practise. The research is concerned with aiding the industry in its integration of circular economy. Based on these aspects the relevant literature was narrowed down to include only current literature and further focused on finding relevant problems through previous researches that have interrelations to the studied areas. The study of the industry background, circularity practices and current company processes is fundamental for this research.

In order to collect the required qualitative data, relevant literature for this research is identified through a digital search of various databases. To achieve searches corresponding to the studied topics, they are filtered by subjects related to the study (Circular Economy, AEC industry, etc.), onto which keywords are used to search the same terms on different search engines, in order to, through peer reviewing, achieve validity of the acquired literature. The research papers are discussed, and ideas are reinforced across several sources, which, in turn, help solidify a foundation for the research. Finally, out of the analysed material concepts, ideas, and conclusions, which are found to be relevant, are used as sources for the research project. It is important to take into consideration that elements, such as publication date, country of the publication, and theoretical research approach of the authors, are taken into account in the literature review process.

2.3.2 Interviews

The second part of the data collection for this thesis is executed through interviews with different actors in the Danish AEC industry. Each of the companies are questioned in two different rounds of interviews. The purpose of the first round of interviews is to create the understanding of the AEC industry and the companies, in order to establish the current status. Based on the data collected during these an analysis is made of the companies comparing them to the industry averages in regards to the implementation of circular approaches. Therefore an identical set of questions, established through the use of the literature review, is used in the interviews. An in-depth description of the development of the questions, can be found in *subchapter 5.2*. The first interview outlines the current standards of the industry, who the companies are, what they do, and where they stand regarding circular economy.

The second round of interviews looks deeper into specific processes and approaches within the companies. The process of developing these interviews is further explained in *subchapter 6.1*.

Both sets of interviews are executed as semi-structured interviews. The semistructured approach is a technique which is used for the collection of qualitative data. Questions are developed in an open manner in order to get complete answers that show the knowledge and opinion of the interviewees. Additionally, the questions are designed to minimise the leading of the interviewees to biased answers. Finally, the interviews are open to ad hoc questions or comments from both the interviewers and the interviewees, in order to clarify the meaning of what is stated. The process for interpreting the received data is stated further in *chapter 5*.

2.3.3 Reliability and Validity

Several considerations are made in regard to the methods behind the data collection. As qualitative data collection is performed through the interviews, the first aspect is to understand the transferability of the collected data. Transferability is akin to the notion of external validity used by quantitative researchers, and is enhanced through detailed descriptions (as is typical in qualitative research) that enable judgments about a "fit" within other contexts [48]. Essentially, through establishing the transferability of the collected data the validity can be enhanced. To establish reliability in the data collection, the concept of dependability is applied. To establish dependability evidence which supports that similar findings would be obtained if the study were repeated is gathered. This is achieved through the broad research base of the thesis, where many actors are included in the data collection. Naturally, even if the study were to be repeated in the same context with the same participants, it would become a "new" study, given the ever-changing social world and perceptual shifts (including news events that may change our thinking overnight) [48].

Finally, confirmability refers to objectivity (neutrality) and the reduction of the researcher's bias. In qualitative research bias is an ever-present concern considering the nature of the collection of data. But when the researcher self-reflection recognises this overtly and factors it into the design by, for example, intentionally seeking potentially contradictory evidence predicted by alternatives (essentially different biases or worldviews), less biased interpretations are more achievable. Additionally, confirmability is enhanced by consistency within quantitative research findings which reaches similar conclusions [48]. In the thesis this is achieved through the comparison of the data collected between the research conducted and thereafter creating interview questions, for the different actors, getting their view-points.

2.3.4 Data Analysis

The data analysis is performed with the purpose of establishing understanding and generalisations out of the spoken word and the context in the interviews. To achieve generalisations the approaches coding, content analysis and meaning condensation are used. These chosen techniques are implemented as they allow for a more flexible approach which enables the authors to work out metaphors, to capture key understandings, count statements indicating different attitudes towards a phenomenon, categorise themes, and search for patterns. These are used to devise a proposal that fits the underlying requirements for each type of player in the industry [28].

Coding refers to attaching one or more keywords to a text in order to permit identification of a statement or opinion, this is done in order to offer a more systematic conceptualisation of statements, therefore preparing the information for quantification and categorisation [28]. This is a key aspect of the comparative analysis between the different companies, the industry and the circular ideal in this thesis. Consequently, content analysis comes into play. After coding the elements, the quantifying of such elements is aided by the frequency, meaning if a term is repeated, it will only be analysed once, therefore the specific question will be answered, thus making the repetition irrelevant. The analysis is therefore reduced to a few simple pillars. During this research, these pillars will be assigned to the topics of each question in the interview, and their over-arching areas. Thus, by categorising, the long interviews can be reduced into a few tables and figures. This approach allows for an overview of the interviews which can facilitate comparisons and assumption testing [28].

Finally, meaning condensation entails a contraction of the meaning expressed by the interviewees into shorter formulations. Therefore, long statements are compressed into brief statements where the main idea of what is expressed is rephrased into a few words. This condensation serves as a helpful process that aids the analysis process by looking for natural meaning and clarifying the main themes [28]. This is done throughout the first and second rounds of interviews as outlined issues, concerns and possibilities with the implementation of circular economy are specified as shortened statements.



Figure 2.2: Method Summary

The method for this thesis can be summarised into a visual diagram, which is shown below. The figure shows a streamlined process where the 1st interview is step one, this yields summaries, or what is called "*Raw Data*", then this data is analysed and categorised into the pillars by utilising the table from *appendix A.15*, this categorisation divides the information into pillars, and aids the definition of initial issues for each company. The fourth step is the second round of interviews based on the issues found in the previous steps, the information is again summarised into "*Raw Data*", and further on categorised into pillars, this results in an overall look of the main problems that the companies are undergoing, and suggestions are made to solve these problems.

Outlined above is the method designed and used throughout this thesis. This method allows the authors to complete a systematic development of the thesis. It also aids the creation of valid and reliable results, during this development, or further on, during the development of other researchers' ideas and similar purposes, which utilise different samples within the industry. Through this method the aim of the project can be fulfilled, within the thesis scope, of outlining what is necessary to bridge the gap between the current industry and a circular economy. Therefore, to develop the thesis, a framework for what circular economy means, is defined.

Chapter 3

What is Circular Economy?

It's difficult to pin-point the beginning of the definition of Circular Economy. This is because the term was not defined in its beginnings, it is a system that has been created and improved upon for several decades, adding more and more details to the original concept.

3.1 History

The idea of circular economy was first coined by the American economist Kenneth Boulding in his work titled "The Economics of the Coming Spaceship Earth" (1966). In his work he acknowledges the resource challenges that might be faced in the future. An idea is presented where the Earth has limited resources therefore man must find his place in a cyclical ecological system. This is a prerequisite for the maintenance for human life on this planet, for our system is in essence a closed system with little to no exchanges of matter with the outside environment. The author poses the possibility of placing a cyclical system capable of continuous reproduction of material, replacing the conventional open economic system [6].

Later on, Walter Stahel wrote a paper called "Product-Life Factor" which won the Mitchell Prize, in 1982. In this published paper, the author attempts to show that the extension of the use-life of goods is both a start towards a gradual transition towards a sustainable society, and a strategy consistent with an active and independent role for the private sector. He states that the extension of life of user products is beneficial for both users and private companies, this can be tackled with the inclusion of activities and processes regarding reuse, repair, reconditioning and recycling (4Rs). Along this study it is explained how the short-life scheme is negative for our society as well as the planet, and that fast replacement has been a trend in economic history, this is due to the "fashion-based consumer society". The result of this is incompatible goods and products that are characterised by a lack of re-

pairability. It is shown that there are alternatives for this fast-replacement system. The model for the fast replenishing system, which is also product-life extension, is shown below.



Figure 3.1: Model for the fast replenishing system, which is also product-life extension

This system relies on 4 loops, which refer to the 4Rs mentioned previously. This system creates an economy based on a spiral-loop system that minimises matter, energy flow and environmental deterioration without restricting economic growth or social and technical progress. The 4 loops refer to reuse, repair, recondition (utilise used products or components as a source for new ones), and recycling (use scrap as locally available raw material). If the inclusion of the new system seems far fetched, the author explains that a selection criteria for product-life extension can be used in order to make it feasible. This selection criteria refers to the technological maturity, product maturity and assembly issues [47]. The study draws compelling arguments to explain the possibilities that are available if a loop-system is used. But most importantly, the author conveys the idea that through new designs and life extension practices products can be used over and over without drawing such a tax on the macro and micro economics of the environment where it is set. This concept alludes to the formulation of the concept of Cradle-to-Cradle.

In 1990, David Pearce and Kerry Turner published a book called "Economics of Natural Resources and the Environment", where the authors explain The Circular Economy and argue that natural resources must be taken into account in economics. They state that economic textbooks pay some attention to environmental economics, but this attention is as an "add-on" chapter illustrating how the theory in the rest of the book can be applied to environmental issues, which endangers our economic thinking where it is clear that the consideration of environmental matters affects us. The interaction between matrices considered in environmental economics tends to be more holistic than economics as traditionally construed, thus there is some temptation to accept one approach as "better", which leads to the thought that environmental economics is an alternative economics, which would mean a competition, and this is a muddled view. The optimal view would be to use the main body of economics to derive important linkages between economics

and the environment, as a system. The resources and inputs of an economic system are seen as linear, but the main difference between a natural and an economic system is that natural systems tend to recycle their waste. Economies have no such in-built tendency to recycle, in the main body of the area. Therefore to argue that this cycle is needed, the authors get support from the first law of Thermodynamics, which essentially states that we cannot create or destroy energy and matter, thus whatever we use up in resources must end up in the environmental system, for it can not be destroyed, but, it can be converted and dissipated. Everything is an input to something else. Saying that the purpose of the economy is to create utility, and to organise the economy accordingly, is to ignore the fact that a closed system sets limits to what can be done by the way of achieving that utility. Entropy also poses a physical obstacle in the way of redesigning the economy as a closed and sustainable system. Thus the laws of thermodynamics ensure that instead of having an open linear system, the opposing is more logical, a system must be closed and circular. The authors also state that due to the fact that exhaustible resources are, by definition, due to be exhausted one day, a management approach must be taken to modify rules to allow for them. Two ways they can be integrated are: (1) to ensure that as exhaustible resources are depleted, their reduced stock is compensated for by increases in renewable resources, and (2) to allow for the fact that a given standard of living can be secured from reducing a stock of resources. Technology is proposed as a tool to enable this circular economy integration, but the caveats are two-fold, for new technology does not necessarily mean less polluting and it is not known if technological progress will continue forever, thus making old technology obsolete or irrelevant. Therefore, decisions and processes must be further studied, this is due to the issue where there is the presence of uncertainty and irreversibly regarding natural capital. Economics argue that there are costs and benefits of changing the natural capital stock. If it is reduced it will have to be for some purpose. This shows that systems thinking and analysis of outputs and consequences down the stream are to be analysed in order to define the most beneficial outcome, and to ensure plausible cases of deviations of such plans [39].

As it can be understood the system was aided by furthering ideas about the principle and how to make it a possibility. Various ideas were added to it such as cradleto-cradle, etc. The term evolved for some time, but, in 2013 The Ellen MacArthur Foundation made a concrete definition of circular economy and bound it to its principles in order to allow the system to be implemented in a corporate scale. The Ellen MacArthur foundation published a study where they defined the circular economy. In the publication "Towards the Circular Economy", which was a collaboration between different players, the foundation defined the system with clear objectives and principles, thus solidifying and unifying the private sector approach towards a unique goal. According to the study, the circular economy, refers to an industrial economy that is restorative by intention. This concept is grounded in the study of non-linear systems, this entails the optimisation of systems rather than components themselves. As a consequence this approach involves management of material flows (technosphere and biosphere). This results in a clear distinction between the consumption and use of material, it advocates for a "functional service" model rather than just selling for consumption. The Circular Economy relies on a few basic principles: (1) Design out waste, (2) Build resilience through diversity, (3) Rely on energy from renewable resources, (4) Think in systems and (5) Waste is food [27]. The shift toward this systematic economy proposes several benefits for the service provider, the consumer and the environment. These benefits will be discussed later in the project, as well as, a detailed definition of circular economy as understood by the researchers.

3.2 Governmental Definitions

Circular Economy is part of the plan to save the planet for many governmental entities. This means that definitions and standards for the term has been set up across the world in order to define exactly what circular economy is. As the expectations and directives of both the Danish Government and the European Parliament will effect the development of the Circular Economy in Denmark, and thereby in the Danish Construction Industry, these are outlined in the following subchapters.

3.2.1 The European Parliament

The aim for the circular economy agenda set out by the European Parliament is to have a transformative agenda which creates new jobs, significant growth potential and stimulates sustainable consumption and production patterns. A definition of circular economy was solidified in connection with the development of the 2015 EU action plan 'Circular Economy Package' by the European parliament. The implementation of this circular economy action plan, set out in 2015, is high on the agenda for the Commission as a step towards a more circular and sustainable Europe [14].

According to the definition in this agenda, circular economy is a system where, within the economy, the value of products, materials, and resources is maintained for as long as it is possible. In other words, the circular economy system keeps the added value in products for as long as possible. It adds that, in this circular economy system, materials which are recyclable are inserted into back into the economy as raw new materials creating further value, a measure which should create a more secure supply [13][12] and that in a circular economy the production of waste is eliminated, or at least reduced to the minimum [14]. Furthermore, the definition, set up by the European commission, also outlines the necessity for yet

undetermined, but required, changes throughout the value chains: From design to waste handling. Meaning that in the transition to circular economy a full systematic change as well as technological, organisational, financial, etc. innovation is necessary [14].

The focus on resource efficiency and waste minimisation should, according to the aim for the circular agenda, provide the EU with a competitive edge and stimulate innovation in the face of rapid global resource depletion. Local jobs will be created developing opportunities for social integration. The transition to circular economy should make the European economy more future proof, green and competitive [14]. Finally, the European Commission underlines within this definition that even in the developed circular economy there will still be a level of linearity, as raw materials and small amounts of waste are unavoidable [12]. This admittance shows the realistic reflection of the commission on the impossibility of total circularity, and lays the ground for goal setting which furthers circularity, rather than achieves total circularity.

Up until this point, part of the focus of the European Union has been on proposed actions which cover the full life cycle of products, from initial production, to waste management and recycling. These actions should reduce the environmental impact and simultaneously benefit the economy. This should be reached both through reuse and recycling which will assist to 'closing the loop' for product life cycles, and through energy savings reached by extracting the maximum value and use from all raw materials, products and waste. The proposed transition is financially supported by ESIF funding, from: 650 million and from structural funds for waste management, and investments in the circular economy at national level: 5.5 billion [15].

First Vice-President Frans Timmermans, responsible for sustainable development said about the plan for circular economy:

"The circular economy is about reducing waste and protecting the environment, but it is also about a profound transformation of the way our entire economy works. By rethinking the way we produce, work and buy we can generate new opportunities and create new jobs." [15]

As just outlined, the EU started on establishing circular economy in 2015, with the exception of the 2014 development of the zero waste program. This was then, in later years, followed by the danish government developing their own plan for circular economy and through this establishing what circular economy would be for Denmark.

3.2.2 The Danish Government

The Danish Government is in these years highly focused on the development and implementation of circular economy in the Danish industries. This is clear through the installation of the Advisory Board for Circular Økonomi (Red. Advisory Board for Circular Economy) in October 2016. The board made the statement: "The increasing consumption of the World makes it necessary to go from a linear to a circular economy." attaining to the need for circular development in the report 'Danmark skal være verdenskendt for cirkulær økonomi' [3].

The development of the paper 'Strategi for Cirkulær Økonomi' (Red. Strategy for Circular Economy) by the Advisory Board for Circular Economy is a clear testament to the urgency with which the Danish government is addressing the implementation of circular economy [32]. In the development of this the working definition of circular economy in a Danish context has been developed. This is outlined as an economy in which materials and products are recirculated in order to utilise the full value potential, and where the waste production is minimised. Instead of throwing away products and demolishing buildings when they no longer serve their initial purpose, in this economic system, these are designed to be repaired, reused, and ultimately recycled. Furthermore, in a circular economy, the production of materials and thereby waste production will be limited by, both, more efficient utilisation of resources as the excess production and possible waste from one company is included as valuable raw materials in another, and a reduction in ownership of things through easier access to things, and the use of things, without owning them yourself. This more circular approach in both production and consumption will reduce the need for virgin materials and thereby ease the pressure on the environment [32] [31].

Specific focus areas have been put into place by the Danish government, creating attention on narrower areas than an overall circular implementation. One such focus, relating to the construction industry is the out-phasing of problematic chemicals, so that waste, and wastewater, can be recirculated as raw materials of high quality [42]. These focus areas, along with the recommendations set out by the Advisory Board for Circular Economy are leading the way for the Danish industries in developing circular economy structures and systems. The recommendations add to the defined circular economy by creating narrowed focus and stepping stones for the Danish companies. These recommendations are listed below.

- 1. The circular thought should be an integrated part of the core business of a company and a task effort of the public in order to develop knowledge and competences in the companies.
- 2. The Danish companies should rethink their design, production and business

models so that they can produce quality products which lasts longer and can be reused more easily. This improves the compatibility as it minimises the expenses for materials and waste disposal.

- 3. We should change the way we make purchases by applying circular principles. In order to accelerate the transition there is a need for the public sector to take the lead. It should be the norm to use life cycle considerations in making purchases and in production.
- 4. Well-functioning markets should be established for waste and reused raw materials. This must make the resources worth more [32].

It must be ensured that, in developing any solutions and implementation suggestions, these are aligned with the governmental plans and definitions, as these can either aid or stall the development of circular economy within the companies.

3.3 Our Definition of What Circular Economy Is

Project definition of circular economy For the purpose of clarity and direction the definition of circular economy applied in this paper will be outlined. The definition will follow the principle of the illustration below.



Figure 3.2: Circular Economy Cycles

As can be seen on the illustration, this system understanding shows how the circular technosphere is inspired by the circularity of the biosphere, the natural system where there is no such thing as waste. In the diagram it can also be seen that circularity is implemented in levels, the smaller the circle, the tighter the process, meaning that less resources and processes the element has to go through in order to be be re-introduced into the system. Therefore, the highest level of circularity is reducing the resource consumption, followed by: Sharing, maintenance of products and buildings, reuse of the existing, refurbishment to achieve new uses, and recycling of materials and products at the highest possible value, to be considered in that order of circularity. In our definition of the principle, as we are working within the frames of possibilities and expectations for the Danish Construction Industry, the demand for circularity is not limited to no waste, but to minimised waste production and optimised resource utilisation. This definition is based on the one set out by the Ellen MacArthur Foundation. As are the pillars, or basic principles, of circular economy, which create the base for the circular understanding in the thesis. These are maintained as:

1. Design Out Waste (Optimisation)

The definition of the principle 'design out waste' which is applied in this thesis refers to the following statements: 'Waste' in this context is everything disposable, this can be wasted materials, money, time, and resources. Anything is considered wasted if it is spent without gains, or without gains to the extent expected, to the project being attained. Design is used as a way to reference all types of design or management initiatives which affect either the physical design and/or the processes applied in the project. This means that creating a design for the project which limits the waste creation is only one part of designing out waste. An equally important aspect is to design and manage processes in the project which will limit the waste production. This means that 'design out waste' among other things can refer to applying production philosophies such as Lean to a project to limit resource and time waste, or, to designing products which utilise a greater percentage of the raw material, creating less material waste. Designing out waste is essentially about optimising the design and the processes to create a circumstance where less material, time, resources, and money is used from the beginning. Based on these observations the term is summarised as 'Optimisation', which will be used throughout the thesis.

2. Build Resilience Through Diversity (Diversification)

The definition of this principle applied in this thesis refers to resilience as the ability to recover from, or easily adjust to, misfortune or change [49]. Therefore it can be achieved by relying on a wider range of options when faced with a problem. This variety, allows companies to adapt to changes, be it monetary changes, working with different companies, or changing their business model to fit new markets. It can be understood as any approach that offers a company, system, or process a higher adaptability to possible changes or fluctuations within the industry as a whole. As a result, resilience through diversity helps companies to mitigate risk. The consideration of new alternatives, or trying new methods also embraces this concept. Throughout this thesis, this pillar will be referred to as 'Diversification'.

3. Shift to Renewable Energy Resources (Renewability)

The definition applied in the thesis of the principle 'Shift to renewable energy resources' refers to removing the dependency on fossil fuels to renewable energies within the complete organisation or within an area which can be transformed. Since this research examines companies as a whole, moving to renewable energies might not be within the span of considerations of a whole company, but creating projects that take this approach can include them within this pillar. Even though, the term seems to refer only to the input of energy, we must also consider the output. Therefore, it must also consider the optimisation of energy outcome from the produced waste. This pillar looks to rationalise the income and outcome products of a company and how they can be re-thought or re-engineered to be received from renewable sources, or to be outputted as such. Throughout this thesis, this pillar will be summarised as 'Renewability'.

4. Think in Systems (Systems Thinking)

The definition of the principle 'Think in systems' which is applied in the thesis refers to a holistic approach, meaning, that every activity, process or element is part of a bigger whole, and recognising this fact. This approach includes the consideration of systems as a whole, and the interplay between their parts and their influence on each other. It is necessary to consider possible or future outcomes of processes, activities and actions in order to establish what the consequences of a decision or integration might entail. In this pillar there is an emphasis on flow and connection between every element (actors, processes, products, activities, purposes, etc). Therefore, for this pillar to be fulfilled the company must look at the industry as a whole, and not just the different actor's relevance in it, or their area of expertise and interest. During this thesis, this concept will be referred to as 'Systems Thinking', underlining the importance of realising that every project includes a system of processes.

5. Think in Cascades (Recycling)

The final principal 'Think in Cascades', also understood under the term 'Waste is Food' [29] is, for the thesis, defined by the following: In the production of materials or products there, usually, also happens a production of waste. The waste production can amount to different aspects, for example: cutoffs from the production of timber, or, excess heat in concrete production. The aim of the principle 'Think in cascades' is to utilise the produced waste in the optimal way. This means creating the highest level of value out of every stage in the life of a product or material. Additionally, it is considered that in many cases one production's waste is the input, or *food*, to another. Meaning that when the waste of a production is transferred and used as raw material in another production, whether inside or outside of the company, the value of the material is maintained at the highest level possible.

Finally, the principle also refers to the extended use of a product achieved through re-purposing or recycling it. The aim is to maintain as high a level of value for the product, for as long as possible, however this may look. For a building this can be the renovation and new function of a building, or the recycling of building materials into new constructions. The recycling of materials is at the core of this principal, and, therefore, the term 'Recycling', has been used to reference this principle throughout the thesis [27].

Meeting these 5 principles will ensure a rounded process where measures towards circularity are taken during all steps of a project development, and only by meeting all these principals will a project or process be fully circular. As stated above, the current aim for the industry and this project is not to achieve full circularity, but to become *more* circular, which can be achieved through the focus on one *or* more of the pillars. Finally, the sustainability of the circular approach must be considered. Is it a given that a circular system is sustainable? By the presented definition: No. Circularity can be achieved without reaching sustainability. As an example of this can be mentioned the reuse/recycling of materials. The reuse of materials is in itself a circular and sustainable solution as it reduces the resource use. But, when materials have to be dismantled, transported, cleaned, transported again, stored, and transported again before they can be implemented in a new project, this whole process, while aiding circularity, is not necessarily sustainable.

Therefore, in this paper the definition of circular economy will be considered to be what is not only circular, but what is at the same time sustainable. Thereby focus will be on achieving circularity which lies within the sustainable frame. A frame defined in the following.

3.3.1 Sustainability

Sustainability is a broad term with rooting back to two beginnings. This division relies on the context of the used term. One of the roots refers to the biosphere, which in turn refers to natural cycles, such as nutrient cycles, carbon cycles, and water cycles. These processes are circular, but do not embody the definition of circular economy as stated previously. The second side of the term, and the one we are referring to when the term is mentioned in the research, allude to the definition

of sustainable development sourced back to the United Nations General Assembly (1987). Where this term refers to the following definition: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [25]. Along this statement, sustainability and its development points to three main pillars that ensure that a system can be considered sustainable if it withstands within these terms. In broad terms sustainable development is a strategy where the aim is to promote harmony among humanity and nature [25]. Therefore the pursuit of sustainable development requires the consideration of the three foundations, or pillars:

- Societal Considerations
- Economic Considerations
- Environmental Considerations

The order of the foundations is not relevant, for there is no priority within the term. Therefore, in order to attain sustainability, through sustainable development, it is required that any action, plan or project takes into account the implications and byproducts of their interaction with society, economy and environment. This is more easily explained as such: in order for any project or action, to be sustainable it must consider the well-being and/or improvement of the society, the economy, and the environment that surrounds the undertaking.



Figure 3.3: Project, Circular Economy and Sustainability

As shown above, on figure 3.3, within the considerations of this research, the placement of each concept is within the diagrammed framework. Therefore, in order to have circular projects, these must be contained within the circular economy definition, which at the same time must be included in the definition of sustainability. Therefore, if a project or solution is circular but not sustainable, it will not be considered circular, or an adequate response to the problem at hand.

As such, a project must fall into a space within circular economy, lying within sustainability.

In the following chapter 4 *The Construction Industry*, the requirements and limits for a project will be defined.

Chapter 4

The Construction Industry

To understand the possibilities and limitations present in this project, an understanding of the context in which it exists must be developed. In this case: an understanding of the Danish construction industry. The Danish construction industry is a 250B DKK business in prosperity making it one of the leading industries in Denmark [11]. But at the same time the Danish construction industry is also considered to be highly inefficient. According to Nazarko and Chodakowska's research of the DEA efficiency in construction industries, the Danish construction industry is one of the least efficient construction industries within Europe [38]. At the same time, the construction industry is one of the biggest industries in Europe, responsible for 8% of the workforce, 20-35% of the significant damages to the environment, 33%of the water usage, 40% of the material usage and 40% of the energy usage [51], as well as being responsible for 34% of the waste produced in all of Europe [17]. In addition to this, the Danish construction industry is responsible for 35% of the waste produced in Denmark [33]. This production of waste occurs in connection with construction, remodeling and demolition. As can maybe be expected most all of the produced waste happens in connection with remodeling and demolition, while only 5-10% of the waste is produced in connection with new construction [33]. While looking into the resource use and waste production of the industry it is also important to understand that while the construction industry has one of the highest productions of waste, it also has a one of the highest recovery rates of the produced waste. On average the Danish construction industry recovers 85% (2017) of the produced waste [33], and the European industry 89% on average [18] [35]. The problem that remains, is that the recovery of these materials happens largely on the lowest level of the material value, so that, for example, concrete is, mostly, recycled by crushing it and using it as fill in substructures and roads [33]. Through this type of recycling the materials loose most of their value during the recycling process compared with a reuse process where the material is used in its originally produced state of higher value. In addition to the resources spend and wasted in the Danish construction industry, another reason the construction industry is such an important factor in the development of circular economy and facilitating change, is because buildings have a longer life span that almost all other products, this means that the decisions we make today regarding the way we construct will stretch far into the future, creating a much more long-lasting effect of implemented changes, while everything constructed previously to now, will also affect the market in the coming 10, 20 or 30 years [30].

In order to develop a sufficient understanding of the industry it is important to have an overview of the processes which characterises the way the industry works. An overview of the general processes of the industry as well as the involved actors will provide valuable insight. Therefore these will be outlined in the following subchapters.

4.1 General Processes

The construction industry generally works within set frames, making most projects develop in a similar fashion. However, individual projects are framed by the so-called *Project Triangle*. This dictates that for any project the factors *time*, *cost* and *scope* are all interdependent and frame the *quality* of the project.



Figure 4.1: Project Triangle

The basis of this project understanding is, that if one of the three factors increases, so must the other. Meaning, that if the scope of the project gets bigger, so must either the time or the money in the project, probably both. At the same time, if the time or money put into the project are decreased, so must either the scope or
the quality of the project. The interconnection of these 4 factors is the basis for all developed projects and affect the way projects are developed every day in the industry [37]. The effect that a change in one of the factors will have on the others is depended on both the magnitude of the change, but also the time-frame for making the change and the involved actors.

4.2 Actors

The actors of the construction industry are the involved entitles, also called stakeholders or players in the industry. By using the term actors, is referred to only the stakeholders with active participation in the project development, whereas stakeholders cover all affected parties in connection with a project. Each of the actors usually involved in the project processes, and thereby involved in the circularity of a project, are outlined in the following.

Clients, the client is, perhaps, the most important actor in the construction process, as without a client, there will be no project. The client determines the requirements for the project, the time-frame, the budget, the use and the physical appearance of the project. The influence of the client is dependent both on the type of contract and the clients themselves. The client can determine everything about what goes into the project, and is therefore largely responsible for which materials, process and work is used in the development of the project [20] [37]. Maybe the most important consideration which must be made in regard to the client is that there is significant difference in whether this is a public or a private client. The differences between a private and a public client are essentially that a public client is spending government funds to support the project, while a private client is spending personal funds to support the project. This means that the public client is underlain a number of stricter restrictions in regards to how the money can be spent in the project and how the duration of the project can be handled. Essentially, the public client *must* tender the project in a price competition, in order to ensure that the money is spend wisely and that the process is transparent [20].

Advisors, the advisor can be an architect or an engineer, or something else, and their job is to advise the client on the best processes and values for the project. The advisor mainly has contact directly contact to the client, this means that the advisor can have a large say in which processes, materials, etc. are used in the project, and is usually not contractually connected to any other actors in the process [20][37].

Architects, the architects are part of the design and advisory team who take the requirements and wishes of the client and use these to design the project. The architects have a large influence in the material choices made for the project, and can

influence the client to make different decisions both in regards to processes, design and materials [20]. Depending on the contract form the architect is connected with either the client, a turnkey contractor or both[37].

Engineers (of different areas), the engineers are part of the design team. Usually their primary function in the project is to, in collaboration with the architect develop and ensure the design of the project. Like the architect, the engineer is usually connected contractually to either the client or the turnkey contractor, or even the architect. The engineer is the entity involved who approves the use of materials and frames for the project, and thereby has a large influence on the possibilities for the project development [20][37].

Contractors, there are several different types of contractors which can be involved in a project, and, usually, at least a few different will be. The main three categories are: Turnkey contractors, contractors who tender for projects which include both design and construction, main contractors, who tender for the construction of larger projects, and trade, or sub, contractors, who tender for smaller projects or smaller parts of larger projects only attaining to a specific area of the construction, for example carpentry, masonry etc. [20][37]. In a traditional main contract the contractor has very little influence on the choice of materials used in the project. Instead, they will, usually, choose the cheapest materials which meet the requirements of the client set out in the tender material. This means that any requirements like sustainability choices have to be determined previously to this, unless recycled materials are cheaper to acquire and also meet the set out requirements and therefore can provide a profit for the contractor. The same expectations can be set out for the trade, or sub, contractor. The turnkey contractor, however, is, as mentioned, involved in the design process of the project and will therefore have significant influence on the material and processes applied in the project already in the design phase [20].

Supplier, the suppliers are the companies supplying the materials used in the construction of projects in the industry. The suppliers in the industry, have significant influence on the materials available to the project developers, but have very little influence on the chosen materials for the individual projects. The influence they have is in the form of the availability of materials, as well as pricing and deliverability of materials into the market. Therefore they are able to influence the possibilities for the projects, although they have little connection to the design phases. The connection to the project and design phases is dependent on the contract type used in the specific project [2][20].

Facility Management, the facility managers are companies which are hired, typi-

cally by the client, to take care of the operation and maintenance of the building. The facility manager has a unique understanding of the use of the building and the issues which may occur over the years of running the building. They therefore have valuable understandings and information for the design of the project, but are rarely involved in these processes [2].

Demolition Expert, the demolition expert is a type of contractor, but can also simply be a department within a contracting company. The demolition expert has the knowledge and ability to demolish buildings, but also to harvest and understand the materials made available in the demolition. Usually when a building is demolished the demolition contractor takes over ownership of the materials of the demolished building. Therefore the demolition expert has the ability to become suppliers of materials into the market and thereby influence the available materials and project opportunities [2].

The described actors are considered to have influence on the circularity and development of the project in descending order. This means that the client has the largest impact on the choices made in the project, while the demolition expert has the least. This should be considered in the analysis and understanding of the different company roles in the projects, as some will have the possibility to make a much larger impact than others. Essentially, the later the actor enter the project process, the less influence they will have on the material and process choice. To further outline this understanding, the phases which make up the Danish construction industry are outlined the following subchapter.

4.3 Phases

Projects within the Danish construction industry, generally, go through 6 different phases: Planning, Design, Tender, Construction, Operation and Maintenance and Demolition [20][22][37]. How these phases are realised is largely dependent on the type of contract used in the project [37]. Traditionally these phases have been very clearly divided and different actors in the industry have been, for the most part, contained within each of their own areas [20][36]. This traditional approach has over the later years changed to an increasing degree [20][23]. First, not so recently, the turnkey contract involved the contractor and the architect at the same time in the design phase, or at least created a higher level of collaboration between the contractors, architects and engineers in the industry. Later developments are Partnering and the Public-Private-Partnership (PPP) contracts, which, still, are new concepts in the construction industry, but which stretches the contractors' responsibilities all the way through the Operation and Maintenance phase [23].

The phases of a typical construction project will be explained below in accordance

with the procedure of a main contract, the most significant deviance from this within other contract types will be further explained in the following subchapter *4.4 Project Types*.



Figure 4.2: Phases of the Danish construction industry

4.3.1 Planning Phase

The planning phase is the first phase of the project. In this phase contact is established between the initial actors, traditionally, in a main contract project, this is between the client, the client advisor and, potentially, the designer. The so called 'Brief Design' is developed which outlines the idea behind the project and the client wishes and requirements, for example the use of the project, the scale of the project, an initial budget, time-frame, and design concept. This phase concludes in a decision of whether to proceed with the development of the project, based on the determined frame, and, if so, a 'construction program' which outlines all the parameters which will affect the design of the project in the following phase [36][37]. The Planning phase is, as mentioned, the phase in which the client is connected to the client advisor and designer. This also means that this is the first opportunity for other actors in the industry to influence the project, including influence on such things as sustainability goals, design concepts and uses of the project [20][36].

4.3.2 Design Phase

The design phase is further divided into four phases, the Outline Proposal, the Scheme Design, The Detail Design 1 and The Detail Design 2 phases. These are the phases which traditionally outline the relationship between the architect (or designer) and the client. The outline proposal is the phase in which the most important design decisions are undertaken by the client and the designer [36]. This is followed by the Scheme Design phase, where decisions for the project are finalised though material choices, ensuring conductibility and developing measured spaces within the project [36]. The Detail Design 1 (DD1) phase is intended to develop the project to a level at which it can be approved for a building permit [36]. When the building permit has been obtained the final design phase, the Detail Design 2 (DD2) is started. In this phase the aim is to finalise the drawing for the construction of the project, including the finalised plans, details, time schedules, budgets etc. When everything has been developed the material is sent to tender between

contractors [36][37]. In actuality, in the Danish construction industry, these phases are a lot less split and defined. As projects develop several phases can often overlap or even be running as the construction of the project has already started, this typically happens because of tight time-frames for the projects, maybe as an effect of tight budgets.

4.3.3 Tender Phase

The tender phase is the time period in which the materials developed in the DD2 phase of the project are send out to contractors and these develop and submit a bid for the construction of the project. The contractor is, usually, chosen based on lowest price along with other criteria which has been applied to the submission by the client, client advisor and architect. Tender also happens at other points in the project work. For example when suppliers have to be found for the supply of building materials, here tender can allow for finding the supplier with the lowest price for materials. The tender phase is executed in almost the same fashion regardless of which contract is applied in the project. What differs is at which point in the project process the tender phase is undertaken. This will be further outlined in the subchapter '*Contract types*' below.

4.3.4 Construction Phase

The construction phase of the project is, as it may be obvious, the phase in which the project is constructed. Construction in the Danish construction industry, typically, happens as a collaboration between a number of different contractors each with their own speciality and with responsibility for separate parts of the project work. Typically one contractor, in the case of a main contract - the main contractor, is responsible for the coordination of the construction site and the contractors present on the site [36][37]. Once the construction phase starts all decisions about the project should have already been made in the planning and design phases and the determined requirements and limits from the design and tender phases should be followed, but, it will enviably happen that decisions in regards to specific solutions and constructions will have to be made on site during the construction [37]. After the completion of the construction, the project is handed over to the client. at this point the ownership if the project on site changes hands from the contractor to the client. This happens after the project walk through in which the involved actors participate to ensure the completion and quality of the project. Traditionally, this means that the contractor's responsibilities are from then limited to the 1 and 5 year guarantees on the project [36][37].

4.3.5 Operation and Maintenance Phase

As the project is handed over to the client the use of the building can be begun. This phase is called the operation and maintenance phase. This phase stretched from the project is taken into use until it is demolished at the end of its lifetime. Over this period of time then demands for the building and the use of the building will usually change. This means that changes must be made to the project along its lifetime. The magnitude of these changes is entirely dependant on what the use changes are and the level of of flexibility that was included in the project in the design phase. The more flexible the building is initially designed, the longer use can be expected, but larger flexibility, usually, also means larger construction costs [1]. Typically the client is responsible for the operation and maintenance of the finished project [37]. However, depending on the type and the size of the project a company may be hired by the client to handle control of the more complex systems within the project and the maintenance of both technical and structural aspects of the project. The service companies hired to provide this service are, usually, specialised companies separate from the construction companies, and any other companies, who have dealt with the project up until this point [1]. Some larger construction companies have departments within, which are specialised in operation and maintenance, but, typically, these are separate units from the rest of the company and work on separate projects with no connection of the construction. This all means that typically, and traditionally, there is no communication between neither the design phases nor the construction phase, and the operation and maintenance phase, and the actors involved in these different phases, during the design and construction of the building [1].

4.3.6 **Demolition Phase**

The final phase in a project life cycle is the demolition phase. In this phase the project has fulfilled its purpose, or has been outgrown in its ability to, and the project is therefore demolished, typically, with the intend of reconstructing a project with a similar purpose, or a new project on the same location. The demolition can happen under different circumstances, but typically a demolition company will be tendered for the job [1]. What's important to note i regards to the demolition of the project is the approach to the demolition and the responsibility for the produced waste during the demolition. As mentioned previously, the majority of the produced waste in construction is produced in connection with demolition and renovation [33]. Of course this means that, in the execution of these phases focus must remain on the handling of the waste. As a starting point the client has the ownership and the responsibility for the materials, but typically this will be transferred to the contractor by the contract between him and the client. Whereby the contractor will be in charge of disposing of the waste from the demolition according to the Danish regulations regarding construction waste disposal. The Danish government has extended the 'Vejledning om håndtering af bygge- og anlægsaffald' (Red. *Guidance on the management of construction waste*) which dictates how construction waste should be sorted, recycled and disposed of in order to ensure a more sustainable process [31]. Currently in Denmark up to 80% of the construction waste is recycled as high quantities of demolished concrete is broken down and used as gravel in the construction of roads and sub structural fill [33]. This type of recycling is also called down-cycling, and is of a very low level, as only the minimal values of the material is maintained throughout.

The actual process of the project varies from project to project and is, as mentioned, affected mainly by the project contract. Therefore the project types primarily used in the Danish construction industry will be outlined in the following chapter.

4.4 Project Types

Within the construction industry there is, traditionally, a stark division between the different steps in the value-chain. These are all connected through contracts which vary dependent on the actors connected and the type of project. The contract type used in a project is highly influential on which actors are involved in the project, when they are involved, how they communicate and who bears the risks connected to the project [8]. Traditionally the construction industry works in four different project types: The turnkey contract, the main contract, the grouped contract, and the trade contracts, all contracts between the contractor and clients/building owners/contractors [36][37].

In addition to these contract types newer types have been developed and implemented on the Danish market: the PPP and the Partnering contracts [37]. The different contract types and their effect on the project progression will be outlined in the following.

4.4.1 Trade Contract

A trade contract project is a project in which each of the construction areas within the construction are tendered separately. In this project type it is the responsibility of the client to operate and plan the construction, the site and the individual contractors. There is no connection or official communication between the different contractors, nor between the contractors and designers. The client, or the client advisor, is, therefore, responsible for the sharing of all information within the project [37]. This is why this project type is highly demanding for the client and usually only used by professional clients. Even then, this contact type is rarely used because of the logistical issues which can easily occur with the coordination of different contractors' time-schedules, responsibilities and task areas [20]. The development of the project phases happens according to the timeline outlined above. The difference to the main contract mainly lies in the ownership of responsibilities and coordination tasks in the project.

4.4.2 Grouped Contract

The grouped contract project works, on all accounts, very similarly to the trade contract project. Rather than every contractor being employed completely separately, they are grouped together, into groups of for example *structures, finishes*, etc. These groups are then tendered and each group managed by the client as individual companies would be in the trade contract project [37]. This project type is also highly taxing for the client and is used pretty much as rarely as the trade contract [20]. Again, this project type follows the same structure of the phases in the project as is described in the chapters above.

4.4.3 Main Contract

The main contract is between the client and a main contractor, the development of the project proceeds as outlined in the previous subchapter *4.3 Phases*. In the main contract the client only tenders to one company, this tender happens after the design of the project, handled by either some or all of the following: client, client advisor, architect and engineer [20][36]. The winning contacting company is then responsible for the managing of the construction, the site, and the execution of the construction according to the outlined design by the designers and client. According to the workings of the contract the main contractor is responsible for delivering the project in accordance with the tender material, the time-frame, and the bid provided [1][37].

When using this type of project it is the responsibility of the client to coordinate the design phase and the tender phase, after which the main contractor takes on the responsibility of the construction and any hired subcontractors. This means that if deviations to the contract is found in the finished project, regardless if it is at fault of the main contractor or the hired subcontractors, the main contractor is liable for the issues [37]. This contract form provides the benefits of reliable but competitive pricing from the main contractors [40], but also creates significant limits in the communication and efficiency of the project process [50].

4.4.4 Turnkey Contract

When using a turnkey contract, the tender of the project happens before the design phase. In this case, not only the construction of the project is tendered out, but with it, the design and drawing of the project as well. In this type of contract the turnkey contractor holds the responsibility for the complete coordination of the project, making it an easy and safe contract type for, especially, the non-professional client [37]. In the development of the project more of the actors are involved at an earlier stage of the process and the contractors participate in the design phases along with the designers. This increases the communication between the different actors in the project and ensures that the perspectives and concerns of the contractor are included in the design of the project [20][37].

4.4.5 Partnering

As mentioned earlier, partnering is a newer project form compared to the 4 outlined above. This is represented in the industry by the fact that this type is used less frequently. The main difference between partnering and the more traditional contract forms is that technically, partnering is not a contract form in the traditional sense at all [23]. Partnering is based on trust and openness between the involved parties, and focuses on conflict solving. In partnering a common vision and common economic interests between the involved parties are the basis of the collaboration. The client involves the advisors, designers and contractors early in the process in order to create a common ownership feeling. Decisions are made in this forum in order to enable the possibility of a secure project in terms of both the quality, time and economy. One single agreement is made between all the parties in the project, rather than separate agreements between each of them, in order to ensure aligned interests in the project [20][23].Usually an economic incentive or bonus is a part of the agreement. For example savings made in connected with the optimisation of constructions or processes can be divided between the different actors, increasing their earnings. The partnering project type is typically attached to a contract in accordance with those contract types mentioned above. In order to limit the amount of involved actors in the partnering agreement it is usually build up around a turnkey contract. Here the contractor chooses the designers to collaborate with, giving the client the idea that the actors already have positive knowledge of each other and are able to collaborate well [20]. It has to be noted that the partnering process requires a much larger involvement from the client than what is normally seen in any of the traditional contract forms; the price of the increased influence on the quality and process of the project, that actors in the industry are sceptical of processes such as these, as it is believed that the tones, morals and norms in the industry are too harsh and selfish for this type of collaboration to function optimally, and finally that partnering includes a large risk that the budget will not hold, at the chance that any one of the parties involved chooses to further their own economy rather than the common project economy. These are some of the main reasons that this collaboration form is seen less frequently in the industry an they underline the necessity for strong and mutual agreements to the united benefits of the project at the beginning of the process [22][23][37].

4.4.6 Public-Private Partnership (PPP) Contract

Where the client is typically responsible for the operation and maintenance of the finished project following any of the above mentioned project types, a PPP project includes this aspect into the tender. In this type of project the contract is typically 15 to 25 years long, but can last up to 35. A period over which the executing company is responsible for the operation and maintenance of the project [26][37]. One of the main advantages of this project type is the ability of the executing actor to make considerations towards the total economy of the project. This is done by applying knowledge of the operation and maintenance to the design considerations. With these considerations log term financially beneficial solutions can be made in the design and construction phases [26]. Additionally, has the division of risks in a PPP project been systematically divided to ensure that the public and the private entities are responsible for the risks which they can most easily and economically handle [26]. To add to this, is one of the main drawback of this contract type that it requires a strong and professional client, who can ensure their own influence in the project. The organisation of the PPP contract differs greatly from the more traditional contract types in the industry in that, usually, the client will develop a contract with a project company', whose sole purpose is to collect the contracts between all of the involved actors [37]. The structure of these contract connections can be seen on the image below.

Each of the outlined contract types and collaboration structures create different frames for the project process and the way the different actors are able to collaborate within the project. The project frames are described in the order of what is generally considered the least, to the most, collaborative format. This means that in the trade contract the least amount of established collaboration happens between the involved actors, while the collaboration is high across all involved in the PPP and Partnering contract. To create an overview the areas covered by the different contracts are outlined on the figure below.



Figure 4.3: Contract Areas [34]

There are, as outlined, depending on the project type, different issues, or hurdles, which can hinder the development of more circular project work.

It is the assumption that, as the contract determines the collaboration happening between the different actors in the project, it creates more difficult circumstances for the development of successful circular processes when working with the less collaborative contracts.

As it has been stated through this description of the different project phases and contracts in the construction industry the roles are highly fragmented, and most collaborations are determined based on a monetary benefit to the tendering party. The tendering process, to a high degree, shapes the structure of the industry the effect of this is outlined below.

4.4.7 Economy

The current economic model in the construction industry, as in most other industries is a linear economic model. This model is based on the principle that new resources are extracted from the earth, made into the products needed, and, when they have fulfilled their purpose, disposed as waste. This model sets high demands for the input of new materials, and requires that energy is spend on extracting as well as producing every time a product is needed. Therefore, this system is highly reliant on the use of fossil fuels [4], and produces high levels of waste, as outlined above. Currently, an amount of resources which equivalents to 1.75 Earths, are used every year, a fully unsustainable rate [21], and waste is becoming a severe environmental problem, a societal burden, and an economic loss if it is not reused or recycled [16]. A more circular economy will aid these issues, but before this can be implemented, the basis of how the Danish construction industry works has to be addressed.

Firstly, the base of the Danish construction industry is, as mentioned, the tendering process which shapes the way projects are developed, and how companies and actors are interacting and collaborating. Depending on the situation of the project, the execution of tender differs. If the client is public, strict tender rules must be followed, and the whole project must be tendered in order to ensure transparency and equal opportunity [2].

The tender process has been explained in the subchapter Tender Phase above. It is, essentially, the process of having companies bid for the work which needs to be executed at each stage of a project. This means that, there can be a tender process between each stage of the project, meaning that architects can be bidding to draw the project, main contractors to manage and develop the construction, sub-contractors to partake in each of the different construction areas within the project and suppliers to deliver the materials to the project. In addition to this, facility managers may be bidding to run the building during use and, at the end of the lifetime for the building, demolitions expert may be bidding to perform the demolition of the building. Traditionally the choice of project partners within a project has been determined by this competition on price [22]. The use of tender within each connection of the project makes it difficult to choose your collaboration partners, it creates a high pressure on the profit margins of the tendering entities, and thereby creates a pressure to deliver at as low a cost as possible in order to maintain, an already small, profit margin [22]. All of this adds to the difficulty of developing a more circular process, as this requires collaboration, common goals and, for now, innovation.

4.5 Where Is the Industry Now?

The final step in outlining the current status of the Danish construction industry is to look into the steps that have already been taken towards a more circular economy.

Even though the EU and the Danish government are currently trying to make the construction industry into a more circular one, there have been initiatives taken on by private companies and foundations that wish to show that circularity can be achieved to a greater extent than what the Business as Usual proposes. These initiatives range from recycling demolished concrete, the utilisation of data within the construction sector for optimisation, using buildings as material banks, design for disassembly, and many others. According to reports set out by Teknologisk Institut

the industry is already opening up to the possibilities of circular processes. Their studies show that every other company ready for circular economy, that every fifth counts on recycled materials and that, primarily, bigger companies are betting on recycling [45][46]. On a project scale, certain practices have been created in order to create prototypes that prove the implementability of circular buildings.

On the forefront of the Danish construction industry, in regards to the implementation of circular practices, one of the most relevant projects is *The Circle House*. This project focuses on integrating several circular economy practices under one housing project. This project involves over 60 Danish companies across the entire industry, creating a massive collaboration that aims to develop, propagate and verify knowledge about the circular construction industry. This project can be considered the lead in knowledge sharing and testing of the circularity concept in order to confirm its feasibility and future possibilities. The basis for this project is an in depth research of different projects and initiatives, in the construction and other industries. The most notable mentions studied are examples such as Green Solution House, B/S/H, Brummen Town Hall, Advance Nonnowen, Ege Carpets, Refurb. In this projects practices such as Design for Disassembly and Material Passports have been successfully implemented [44]. Another noteworthy mention is The Circular Building from Arup, which is a building constructed, as a prototype for circular processes, in 2016, out of fully re-usable components [19].

There are non-profit foundations such as Circular Construction Challenge, which is a competition that aims to address the global problem of waste overload, mass consumption and continuously increasing resource use. The competition calls for innovators to help solve this problem and three winning teams will be chosen to help turn their ideas into a solution for the market. Additionally, several companies are working on creating circular buildings and economies as a core for their business. For example, Kingo Unika is a division of the company Kingo Recycling a/s which sells materials and fixtures of high quality, they come from demolition works. Other companies such as Earthship Biotecture, which builds autonomous houses, teach people how to build them, and organise sustainable development and poverty relief projects.

In contrast, companies such as GXN, Lendager and others. Aim to lead by example, creating projects centered around circularity principles, both in design and construction methods. Their key concepts revolve around circular economy practices, and instilling flexibility in design and construction that allow the built environment to adapt to future changes both environmentally and regarding users' new demands. These and many other companies take it upon themselves to work with a more circular approach than what is the norm. Thereby, proving that the shift from a conventional business model to a circular one can be possible. The outlined background of the Danish construction industry creates the understanding on which the remainder of the thesis, and the following interviews with companies in the industry, will be based.

Chapter 5

Identifying the Gap

The first round of interviews are conducted in order to develop an understanding of the companies, the company types and the industry in general. During these interviews all companies were interviewed using the same set of questions. This allows for a data collection which can be the basis for a comparative analysis. The qualitative interview answers are transferred to quantitative data sets which enables the comparison between the companies and the industry. Before the development of the questions, an basic understanding of the interviewed companies is outlined.

5.1 Company Presentations

Before further delving into the interviews and the collected data, the interviewed companies will be presented. This is done in order to create an understanding of the differences in the companies and their placement, and relevance within the construction industry. As well as creating an understanding of their representation of the industry as a whole, as the sample is used as industry representative throughout this thesis. It should be noted that the sample group is limited by the availability of resources in the project. For a project of larger scope, and with additional resources, a much larger collection of companies will be necessary in order to represent the industry adequately. As this is realised, but impossible to achieve within the scope of this project, focus in the selection of the companies has been on creating a broad representation of the different companies involved in the industry.

5.1.1 Architects

Lendager

Lendager is an architectural company with focus on the sustainability and circularity of the built environment. The company has three branches, the ARC, which is the architectural department, the UP which is a product development department with focus on innovation in upcycling, and, finally, TCW (The Circular Way) the advisory department within the company, which advises other companies towards sustainability and in understanding trend-forecasting, strategy development etc. At Lendager, sustainability is always at the core of projects and the company is a front runner in the area of circular economy in Denmark, and strive to not only create sustainable and circular projects, but also to be a sustainable and circular company. The company is medium-big, as it has 50 employees, 25 of which are employed in the ARC department, the department within which the interview was focused, as this is the primary connection to the construction industry in the company.

LINK

LINK Arkitektur is one of the leading architect offices in Scandinavia, in terms of turnover, number of employees, and number of projects completed annually. The company is big, with approximately 500 employees in Norway, Sweden and Denmark together. The company focuses on creating space for specialisation and focuses on excelling within specific fields. The company expertise expands beyond construction architecture into planning, landscaping, interiors and the maritime/offshore sectors. The projects the company undertakes include residential and commercial buildings, transport, industry, urban development, public buildings, sports facilities, health care and education/research facilities. All of which they have developed expertise in. In the Aarhus department, formerly the independent company Aarhus Arkitekterne, a leading position within the design of public institutions such as hospitals and schools is maintained. The company represents the traditional architecture companies found in the industry.

5.1.2 Engineers

NIRAS

NIRAS is an advisory engineering company, which holds one of the leading positions in Scandinavia. The company works on projects within the areas of construction, infrastructure, supply, energy, climate etc. The Aalborg department of the company, interviewed for this project, mainly focuses on client consulting and design of buildings in collaboration with architects, but also works with construction management in a separate department from the design development department. NIRAS's self-proclaimed aim is to create well functioning buildings, sustainable environments, and dynamic infrastructure. As a big company with more than 2000 employees worldwide, 800 of which are within the construction departments, NIRAS has offices in Europe, Asia and Africa.

5.1.3 Contractors

Dansk Boligbyg

Dansk Boligbyg is a consulting contractor. Meaning that the company purely manages construction projects and does not employ tradesmen of their own, but rather hires subcontractors to perform all construction on their projects. As a result of this the company employs approximately 100 employees, placing them in the mediumbig category, while they solely perform big scale projects of 50 million and up for professional clients in the industry. Dansk Boligbyg primarily works with turnkey projects, though at times also executes main contracts.

Enemærke & Petersen

Enemærke & Petersen is a big contracting company, with more than 700 people employed in all of Denmark. The company primarily works with renovation in the 'regulated' market, meaning public and half public clients. Of course, this affects the company as these types of projects are subject to more extensive regulations than private projects. In addition to these projects, they work with new construction for private clients at a smaller scale. Thirdly, the company works within strategic partnerships. These partnerships are with Copenhagen Municipality and the housing association KAB. These partnerships are a collaboration of architects, engineers, contractors, advisors etc. all of whom, over a period of 3-6 years, are sitting at the same location and are working on, not one, but many projects together, keeping the same people involved. With the benefit that the collaboration is much improved compared to standard processes in the industry. Enemærke & Petersen is an example of a contractor, within the danish industry, which focuses on social sustainability and collaborative models.

MT Højgaard

MT Højgaard is one of the biggest and oldest contracting companies in Denmark, with more than 4000 employees worldwide and a 100 years of existence. Even as the company has this size and magnitude it finds approximately 80% of the approximately 1 billion euro revenue in the Danish market. The primary role of the company is as a turnkey contractor for public clients, working on projects including housing, refurbishment, bridges, harbors, and structures. Two of the biggest fields of expertise within the company are large office and hospital constructions. In addition to turnkey contracts the company also works on projects, usually school buildings, with PPP contracts, which binds them to the management of the executed project for up to 25 years. In the development of projects MT Højgaard aims at improved processes through digitisation with tools such as Visual Design and Construction.

Scandi Byg

Scandi Byg is a contractor specialised in development, production and execution of modular construction. The company is big, with 350 employees across the administration, production and construction departments. The company includes both the contracting and the production necessary to develop modular projects and has, through 40 years of experience in the product development of modular elements, become an expert and a leading force in industrial construction in Denmark. The company usually works with turnkey contracts where the projects are developed around the possibilities and limitations of modular construction. These projects are focused within the fields of homes, offices, institutions, and research and health facilities, for both public and private customers. According to the company vision, the company aims to set the standard for the future of construction through an innovative and sustainable construction process.

5.1.4 Clients

Søren Enggaard

Søren Enggaard is a private development company, representing the interests of private clients in the industry, which buys, sells, rents out, and develops properties and projects. The company is small with only 7 employees, but has substantial financial backing which allows it to act and develop independently. The focus of the company is on developing rental properties, focusing on the location of the projects and the profit potential of the development.

Alabu Bolig

The public client, Alabu Bolig, is a housing association situated in Aalborg, Northern Jutland. The core activities for the company is to tend to the needs of the residents by constructing, renting out, administrating, maintaining, and modernising the supported housing. With a goal of becoming the most sustainable and attractive housing association in Northern Jutland the company works towards ensuring housing for everyone. The sustainability focus of the company is expressed in both environmentally sustainable approaches and socially sustainable goals of inclusively. The members of the housing association, the residents, are the highest authority in the company. This authority is exercised on the company through the General Assembly of residents.

5.2 Development of Questions

Using semi structured interviews, the purpose of the first round of interviews is to develop an understanding of the companies and the industry as a whole, and to create a corroboration of the hypotheses established through the research from

5.2. Development of Questions

a wide perspective within the industry. The hypotheses for each question can be seen on *appendix A*.2.

	Statement	Quote	Source
A	Private companies can benefit from circular economy and they can help push the system.	"Good policy offers short- and long-term economic, social, and environmental benefits. But success in increasing our overall resilience ultimately depends on the private sector's ability to adopt and profitably develop the relevant new business models." "Our case studies demonstrate that the principles of the circular economy—if thoughtfully applied—can provide short-term cost benefits today and some striking longer-term strategic opportunities as well as new profit pools in reverse cycle services"	Towards the Circular Economy: Economic Business Rationale for and Accelerated Transition - Ellen Macarthur Foundation 2013

Figure 5.1: Hypothesis Example

Based on the research outlined in *Chapters 3* and 4, hypotheses have been set out in regards to the opinions, possibilities, and problems in regards to the implementation of circular economy in the Danish construction industry. These are connected to the problem formulation of the thesis, seen in *Subchapter 1.1*, as understanding the actuality on the following topics is essential to answering the outlined questions. The assumptions boil down to the following:

- 1. Private companies can benefit from circular economy and they can help push the system
- 2. There are no "one size fits all" solutions in circular economy
- 3. Companies in the construction sector have a linear approach
- 4. There are a lot of individualistic company processes (each company focusing on personal profit)
- 5. Companies are sometimes short-sighted, and only look for profit
- 6. Larger companies have a more long-term approach so they spend resources to stay relevant (innovation)

The process of developing the questions for the first round of interviews, in order to reach conclusions to these statements, will now be outlined, presenting the aim and process behind. In order to develop questions which confirm or disprove each hypothesis, a reflection is made, where information, needed to validate, is stated, and then developed into a question.

				-
		State size of company and span of portfolio	1	What do you (as a company) do? (Which roles in the construction process do you handle)
	Larger companies have a more long-	Categorize size of company	1.1	How many people are employed in your company?
F	term approach so they spend resources to plan accordingly to stay relevant (innovation)	Do they have a variety of customer segments or just one, innovation varies in each	4	What values are your usual customer segments asking for?
		Long-term thinking has to be shown throughout all	5	What determines who you collaborate with? After you finish and deliver a
		decisions	6	project, are you involved in further processes?

Figure 5.2: Interview Question Development Example

Question 1

The aim of the first section of questions is to establish the company and the interviewee, in order to understand their biases, approach, and position in the value chain. This understanding allows the authors to maintain intent and context when working with the interview data. The question aims to confirm if the company is public or private, state the company's business and interests; and state the size and possibly the span of their portfolio, in order to assess it.

Question 1.1

This sub question, confirms the categorisation of companies as either small, medium or large enterprises, according to Danish law. This will allow to understand the amount of influence a company has on the value chain and if there are any similarities among companies in the same size range.

Question 1.2

This aims to establish an understanding of the point of view of the interviewee, for it may change according to where they are located in the organisational structure. The full list of questions asked in interview 1 can be seen in *appendix A.1*. Above is shown an example of the development of questions 1, 1.1 and 1.2. The remainder can be found in *appendix A.3*, where the development and purpose of them will be outlined.

5.3 Raw Data

The information collected during the initial interviews is compiled in order to organise the data for later analysis, referred to as *Interview Compilation*. The data set can be found in the table in *appendix A.4*. In the shown data, it can be seen that answers to the questions are summarised, this is done to only show the essence of the answer in the most simplistic way, which, in turn, makes the analysis more visual. The summary of the answer is taken considering the context and intention of the answer. In the summary each company is stated, the interviewee name and role is shown as well, the questions and their summarised answers follow this data. For the full interview data, the individual full interview summaries are attached in *appendixes A.5-A.13* and the full sound files can be found in the attached folder in *appendix A.14*.

TypeCompanyIntervieweeInterviewee RoleQ.1 What do you do as a CompanyQ.2 Cos area of expertise / edgeArchitectLendagerMagnus KuhnProject Managerarchitecture and on-site a dvisorsSustainability and designArchitectLINKTorben HeldboProject Managerarchitecture, on site advisors and project Managerarchitecture, on site advisors and project Manager							
Architect Lendager Magnus Kuhn Project Manager architecture and on-site advisors Sustainability and design Architect LINK Torben Heldbo Project Manager architecture, on site advisors and period Taikared design/company size and portfolio	Ту ре		Company	Interviewee	Interviewee Role	Q.1 What doyou doasa Company	Q.2 Cos area of expertise /edge
Architect LINK Torben Heldbo Project Manager architecture, on Taikored site advisors and design/company FM size and portfolio		Architect	Lendager	Magnus Kuhn	Project Manager	architecture and on-site advisors	Sustainability and design
		Architect	LINK	Tarben Heldba	Project Manager	architecture, on site advisors and FM	Taikared design/company size and portfolio

Figure 5.3: Interview Compilation Example

5.4 Data Analysis

The data is analysed by organising the answers received, and assessing their stance according to the definition of the 5 pillars of circular economy outlined previously (*Optimisation, Diversification, Renewability, Systems Thinking, and Recycling*).

During the first interviews the 8 questions were designed to analyse the current state of companies regarding circular economy practices. The questions were de-

veloped to have open answers, where companies can point to the biggest strengths or biggest issues they consider their company, role, or the industry to have. The answers to these questions are then interpreted according to their context, the topic during the conversation, and then analysed and separated into categories. These categories are defined by the span of answers received by all companies, which are categorised according to the table of categorisation, this can be seen in *appendix A.15*. This table states that every answer refers to a category, and each category corresponds to a pillar, or several, by the stated definition. The categories are shown in column 1 in the table, the explanation according to their meaning in the interviews in column 2, and, in the following columns, they are applied to the 5 pillars of circular economy. It is important to state that each category can be part of more than one pillar. This process can be seen on 5.4, as a summary.

Category	Description	Pillar(s)
Client gains	This refers to when a company creates added value to the project, optimising the input into the project for the client.	Optimize
Client's choice	This refers to the company being open to working however the client prefers. This includes multiple viewpoints into the project (Diversification) and the ability to consider the project from several perspectives (Systems Thinking).	Diversification, Systems thinking

Figure 5.4: Table of Categorisation Example

When this process has been completed, the answers from each company for each of the questions is analysed. When the answer to a question refers to a category, this category is assigned with 1 point for each aspect of the answer which refers to this category. If the answer is positive, meaning, that the answer received refers to practices that aids the implementation of this category, the category gets 1 positive point. If the answer is negative, meaning, that the answer received refers to a flaw or has a negative effect to the implementation of this category, the category gets 1 negative point. The totality of the points for every category is tallied, and the points for each category are transferred to their respective pillar. Each answer counts as one point, if the answer refers to 2 pillars, each pillar will be awarded a point. This concludes in an overview of how every company is doing regarding the 5 pillars of circular economy.

After analysing the data a scale, which allows the comparison of the companies interviewed within the company types and the industry, is created. To develop this the total amount for each of the pillars is analysed and the highest and lowest totals of each pillar are used. As the minimum and maximum points are analysed, it can be seen that the highest total is 5 points and the lowest is -5. This result supports the research based assumptions presented earlier in the thesis, as it can

be seen, numerically, that the generalisation, has a negative inclination in regard to circularity principles. While it also shows some positive elements where there has been implementation.

The developed scale allows for an understanding of these numbers in a visual manner which summarises the overall outlook. Based on the tallied values, the scale chosen ranges from 5 to -5, considering only integers. The definition of each value, regarding the implementation of a circular economy principle, is as follows:

5: Optimal: This level is almost unobtainable, it would imply complete circularity. **4: Great**: This level refers to great practices, but it also shows that there is room for improvement regarding the attainment of complete circularity.

3: Good: This level refers to a practice of circularity at developmental level, there is a lot to improve on, but it is a good start that will enable circularity to be developed and implemented in current projects to a certain extent.

2: Positive: This level refers to the intent or capability to start the implementation of circularity practices.

1: Positive Unawareness: This level refers to the current practices of a company that have the potential to embrace circularity, although, the company is not necessarily aware of the ability.

0: No answer

-1: Negative Unawareness: This level refers to the current practices of a company that the potential to stifle circularity in their processes.

-2: Negative: This level refers to the resistance regarding the implementation of circularity practices.

-3: Bad: This level refers to a practice of linear thinking at a developmental level, there are a lot of linear processes, but it can be avoided to a certain extent.

-4: **Damaging**: This level refers to a practice of linear thinking and processes at a root level, most processes are linear and an alternative solution has not been considered.

-5: Abysmal: This level refers to a practice of linear processes that is negatively influencing the whole culture of the company toward the disregard of outside practices and new process developments.



Figure 5.5: Empty Scale and Legend

As it can be seen on this scale, both extents of the spectrum are almost unobtainable. It is very complex and challenging to achieve perfect circularity, as well as its opposite. This opposite spectrum considers that completely opposing circular economy is highly unlikely due to the recent awareness of sustainability in the industry and the actions taken on by the government in order to push a sustainability agenda. Through the development of the scale for each company, an overview of the current situation regarding circular economy is achieved.

The results of the analysis can be seen in *appendix A.16*, where the placement of each company within each pillar is outlined. From these results it is worth noting that, with the exception of 3 companies (Lendager Group, Scandi Byg and Alabu Bolig), the values for the pillar *Renewability* lie in the middle of the scale, meaning they are null. This pillar refers to energy sourcing, which lies outside of what in connected with the processes. Therefore, will the value for this pillar be disregarded in the following parts of the research.

Based on this analysis of the data, an assessment of each of the companies will be outlined in the following subchapter.

5.5 Identifying Trends

The company assessment has the purpose of delving into the status, in regard to circular economy, of each of the companies, and develop comparable data for the companies and the industry. This will enable the companies to better understand their own position within circularity, and which challenges and possibilities they are facing. A description and overview of each of the analysed companies can be seen below.

5.5. Identifying Trends



Figure 5.6: Lendager Scale Results

Architecture firm **Lendager Group** has several branches which help create designs that fit customer needs and ensure customer satisfaction, while including a sustainability approach that considers design usage, flexibility and, on some projects the re-use or recycling of materials is even the main focus. Additionally, some projects consider renewable energy sources and harnessing green energies. These aspects increase the *Renewability* and *Recycling* of the company. Most of the projects are public tenders, or clients with a sustainable approach, if the project is not sustainable it is not taken on. This in turn narrows down the selection of clients and collaborators, all within an industry that is still considered linear with contracts and processes that emphasise this. This is reflected in a lower score on the *Diversification* and the *Systems Thinking* pillars. As the company focus on sustainability increases the optimisation of resources, the pillar *Optimisation* is high.



Figure 5.7: LINK Scale Results

Architecture company **LINK Arkitektur** tenders for projects based on their ability to apply the resources (portfolio, expertise, and manpower) needed to complete the project. In effect of the size of the company they have a large range of portfolios and expertise within the company. Especially their expertise of specific building areas differentiates them from other companies, and has resulted in a high score in the pillar *Optimisation*. To a large extend they work on public projects such as schools and hospitals and thereby has to work according to the Danish tender regulations. But where possible, the reputation is a large factor in who the company chooses to collaborate with. This narrows their market segment and collaborators regarding who they can work with, resulting in a lower *Diversification* pillar, this tender area is considered an industry problem the encompasses narrow ways of thought and linear processes.



Figure 5.8: NIRAS Scale Results

The engineering company **NIRAS** uses their ever-expanding knowledge and portfolio to achieve the necessary expertise to take on any project that they set their aim to. They consider profit as a means to sustain themselves and have a reputation which precedes them. A trait which improves the *Diversification* pillar, and is shown by their customer loyalty and return rate, and takes note of the relations and networking efforts. Good collaborations ensure proper project performance, but like all the others is constrained by the industry's contract forms and linear thinking which make it more complex to work within.



Figure 5.9: Dansk BoligByg Scale Results

Construction Management company **Dansk Boligbyg** has a unique model in the fact that they only perform the project management of the construction process. As a main or turnkey contractor they hire sub contractors to perform all the construction work. They focus on ensuring efficient and solid project management for optimal pricing, which ensures customer satisfaction, thus they are sought for these reasons. They choose collaborators by tenders or reputation which is both limiting the selection of companies, disregarding new/unknown actors, and enforces linear processes and framework due to the industry setting, which usually consider project handover and not a circular development. These factors lead to a lower level in both the *Systems Thinking* and *Diversification* pillars.



Figure 5.10: Enemærke & Petersen Scale Results

Construction company **Enemærke & Petersen** works in turnkey, main and partnering projects. What differentiates them is their strategic partnership approach, which groups teams from different players in an office to work on several projects, rather than just a single project, this arrangement enables collaborations and trust between the different actors. Thus, they focus on value creation for both customers and teams, relying on their varied experience and knowledge, therefore partners are chosen by their collaboration willingness. This approach allows the company to excel within both the *Optimisation* and the *Diversification* pillars. Projects are analysed for offering alternatives and showing possibilities; how they can be made better. Customers are acquired through network and dialog which is expanding, and their trustworthiness is a lure for new clients, but the industry contract forms are limiting and stifling, which as a byproduct limits collaboration possibility, and they are challenged by the standard distrust within the industry.



Figure 5.11: MT Højgaard Scale Results

The construction company **MT Højgaard** relies on their expanding arrange of expertise levels and variety, and portfolio (previous projects), where reputation precedes them and attracts new and returning customers to new collaborations. Their selection of collaborators is based on reputation (confirmed by their network) and competencies, which might ignore the possibilities of new or unknown partners, lowering the diversification. Their tendering type of work is constraining, and as the industry itself, it emphasises linear practices including the industry's general overview of distrust of others which sums up to create issues for project development, especially considering the pillar *Systems Thinking*.



Figure 5.12: Scandi Byg Scale Results

The manufacturing and contracting company **Scandi Byg** relies on production optimisation and construction to deliver products with their quality, long-lasting modules, which have the *Svanemærket* label. Their products can be disassembled and reused, creating circular possibilities and increasing recyclability. They are sought for their sustainable approach, their efficient processes and their results (customer satisfaction). Projects are looked at as a complete process as the company occupies 2 spots on the value chain, as the contractor and their own supplier. They find customers through networking and tendering, which narrows collabo-

ration alternatives, but counter measure this by trying to establish partnerships if possible. The linear thinking of the industry stifles their full potential, for the contract forms pose problems and difficulties, which create distrust in the chain as a whole.



Figure 5.13: Alabu Scale Results

The public client **Alabu Bolig** has a specific business model, as they are a public company, ran by a democratic board made up of end users. They rely on sustainability, good collaborations, and value creation as a differentiator. They focus on delivering affordable housing, value creation and creating profit on project development. As Alabu is a public client tendering is a big hurdle in their possibilities for more circular project development. The industry contracts, processes, distrust and communications are the main problematic areas during their work in the industry, where they are settled in the eye of the storm due to the nature of their business. This results in the *Diversification* pillar and the *Systems Thinking* pillar being lowered. Additionally, as a company who focuses on creating value for their customers innovative methods and new products are problematic steps to take for the company, as they have to be ensured of the safety and profitability in the use of the products, this includes CE markings on products and applying tried and tested methods in construction, before recommending them.



Figure 5.14: Søren Enggaard Scale Results

The client **Søren Enggaard** develops the projects they choose based on profitability and sells by offering competitive pricing. They rely on their financial independence, which takes them out of the value chain to create one of their own, the possibilities are considered, and decisions are profit driven. All of which lowers the pillar *Systems Thinking*. They consider who to work with by the collaboration willingness and possible partnerships. As a private client they have the possibility of working around the linear processes of the open tender, and thereby have more control of who they are working with and how the projects are developed. Their focus is on the development of contract formulations as communication in the industry poses difficulties while developing projects.

This analysis can be used by other companies to reach an understanding of their own position in the industry, and which areas improvements should be made in order to reach a higher level of circularity.



Figure 5.15: All Companies Scale Results

5.6 General Issues

The analysis of the companies has, in addition to an understanding of their individual standing in the industry, provided an understanding of the general issues in the Danish construction industry in regard to the implementation of circular economy.

The main issues are connected to the motivational factors for the companies, the know-how and feasibility of implementation of the circular processes, and the communication and collaboration within the industry. These issues add to the creation of re-processing, misaligned solutions, and higher costs. These problems refer to the loss and misuse of resources which can not be put back into the system, therefore making the industry more linearly inclined rather than circular. Solving these issues will bring the industry closer to a circular model. However, complete circularity is not feasible, therefore, the focus is on understanding which steps can be taken for the individual companies to minimise the effects of these issues and thereby become step by step more circular.

A big aspect of the issues identified are related to the governmental courses of action which, from the perspective of the companies, will aid the circular implementation. The issues retained to the market and the laws are outside the scope of this project considering that the companies and the industry itself cannot present solutions to overcome these. Here governmental push and directives are necessary, these will therefore only be touched on briefly from hereon out.

The second interview round is completed in order to create a deeper understanding of the companies and the tried and tested methods. This will aid in the development of feasible steps which each of the companies can take to become more circular, and thereby creating a more circular industry through collective small steps, rather than individual pilot projects.

Chapter 6

What Can Be Done?

As mentioned, the aim of the second round of interviews is to delve into the already outlined issues in the industry and create a deeper understanding for the causes of theses. The end goal of this interview is to develop greater insights to the different companies and company types, and thereby find specific solutions, and suggestions to the companies. Solutions which, hopefully, can be implemented in the broader spectrum of similar companies within the industry, with minor modifications.

Based on these aims the questions asked during the second round of interviews were developed.

6.1 Development of Questions

As opposed to the first round of interviews, where all companies were interviewed using the same set of questions, in order to develop a background understanding and a comparative basis, the second round is based on different question sets. The questions were developed with an understanding of the individual companies in mind, based on the information and individual approaches found on the first round. Since every company is unique, the questions are developed individually to suit the company's approach. The process of developing these interviews consists of two parts. In the initial part, the interviewee is briefed of the first interview results: Which of the circular economy pillars the company is strongest at, in which they have the lowest scores, and why. The focus of the developed questions is to understand how the company has achieved this stance, which hurdles they have met, how they have overcome these, their concerns in regard to the implementation of circular economy, and the collaboration and communication within the industry. These questions allow for a better comprehension of what causes the problems of each company, and what has been done to overcome these and other hurdles, they are developed in order to learn of the tried and tested in the companies, their recommendations, and for the development of knowledge of problems which may be encountered by, and methods which may work for, other companies.

6.2 Raw Data

The information collected during the second round of interviews is compiled in this chapter in order to organise the data for analysis. In the shown data the problems found through the interviews is summarised according to each interviewee. This is done to only show the essence of the problem, in the most simplistic way, which still keeps the integrity of the context, and in turn makes the analysis more visual. The problems are compiled from both interviews and collected in one table. A section of the table can be seen below.

COMPANY	COMPANY PROBLEM	
	Sometimes clients reach out for	
	sustainability with the purpose of	1
	greenwashing.	
	Feels that the contractors and	
	engineers are holding back the	
	innovation, sustainability and	
	circularity in the industry	

Figure 6.1: Raw Data Compilation

The full table can be seen in *appendix B.1*. In the table each company is stated, the problems discussed and the interview they were discussed in are shown. For the full interview data, the interview summaries are attached in *appendix B.2-B.9* and full sound files can be found in the attached folder *appendix B.10*.

6.3 Data Analysis

The data received is organised and analysed by sorting of the answers, referring to the company problems, into the table established in the first interview. Here the problems are categorised and added to the pillars in the same fashion as described in subchapter *5.4 Data Analysis*. Thereby, concerns found in both the 1st and 2nd interview and included, this is due to the problems that are found in the first interview are part of the inquiry for the second round, and therefore become part of the problems found and discussed.

Every problem mentioned by the interviewee, within constraints of the scope, are input in the table, and a categorisation of the problem roots is undertaken, similarly to the 1st interview. As mentioned on the 1st interview, each of these categories from table corresponds to a pillar, or several, by their definition, this can be seen on the table. In this table the categories are defined, which makes it possible to define what pillars are referred to by each problem. It is important to state that due to the nature of problems, all of them impact pillars negatively.

When points are tallied, they will be compared to their 1st round analysis and a connection is established. This means that if a company has a low score on a pillar in the 1st round, it should show that that this is where most of the problems are located. A relation must be made in order to motivate companies to implement the suggestions proposed. The purpose of this analysis, is to ensure and show the connection between the problems discussed and the circular economy pillars. This connection points to the fact that if a company is struggling in some areas within the industry, and subsequently fix that problem by applying the proposed solutions, the outcome will be a better performing company through the use of more circular processes, as well as aiding their ability to become more circular as the industry starts to require it.

6.4 Assessment

The trend analysis performed on the problems of the companies has the purpose of outlining the connection between the issues in the individual companies and the circularity pillars, in order to focus the steps towards improvement on the most essential pillars. It also allows for aligning the different companies with the companies of the same type, and with the industry overall. The analysis of each of the companies are outlined in the following.

6.4.1 Architects

Lendager

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.11*.

				PILLARS				
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	The other players focus on building but not reducing material use	2	Linear	1	1	0	1	0
Lendager	Feedback meetings but no format or document	2	linear. Processes	2	2	0	1	0
	In new partnerships other companies collaborate but it is hard to align concepts and approaches.	2	Partnerships, Contracts	0	2	2	0	0

Figure 6.2: Lendager Issue Summary

The architecture company Lendager Group as analysed in the first round, has the lowest scores within the *Diversification* and *Systems Thinking* pillars. Thus the problems found through the second interview should correspond to these pillars. As shown, on the analysis the problems found and discussed refer to the pillars *Systems Thinking* and *Diversification*, in that order. There can also be seen a high issue count in the *Optimisation* pillar. It is important to state that the two main pillars are somewhat related, as suggesting solutions and tools in any of these will likely improve the other as well.

LINK Arkitektur

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.12*.

					Р	ILLAF	۲S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	When winning through competition, the design has to fit the brief, pushing other aspects will add costs and aspects which were not required. It could cause them to lose.	1	Contracts Form, Partnerships, Quality, Sustainability	2	3	3	2	0
LINK	The experience of the company is driving the decisions (the clients trust in the architects' knowledge and experience of what creates a better building (better flow, usespace etc.	1	Reputation	0	0	1	0	0

Figure 6.3: LINK Issue Summary
The architecture firm LINK Arkitektur as analysed in the first round, has the lowest scores within the *Systems Thinking* and *Diversification* pillars. Thus the problems should correspond to these pillars. As it can be seen on the second analysis, the problems found are mainly within the pillars *Diversification* and *Systems Thinking*, in that order. There can also be seen a high issue count on the *Optimisation* and *Recycling* pillars. The number of problems found and discussed within this company are fairly low compared to the other interviewees, this is because, as it can be seen on the table, the second interview was not undertaken due to unsuccessful scheduling. Therefore, the analysis was conducted with data only from the first round.

6.4.2 Engineers

NIRAS

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.13*.

					Ρ	ILLAF	۱S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Price driven industry is an issue	1	Linear, Tender, Profit	2	3	2	1	0
NIRAS	Clients dont really know what they need	2	Profit, Linear	2	2	1	1	0
	Re-design from architects means re-processing for them	2	Dialog, Processes	2	2	1	0	0

Figure 6.4: NIRAS Issue Summary

As the analysis of the first interview shows, NIRAS has the lowest scores within the *Systems Thinking* pillar. After the performance of both interviews it can also be seen that the largest number of dicussed problems are related to the *Systems Thinking* pillar. There is also a need to state that there is notable mention within the *Optimisation* and *Diversification* pillars. Therefore they will be taken into account while providing suggestions. These pillars are connected and, potentially, if one is improved upon, the other is positively impacted.

6.4.3 Contractors

Dansk BoligByg

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.14*.

					Р	ILLAF	RS	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	An incentive for collabs would be	2	Reputation,					
	reputation	2	Trustworthiness	0	0	2	0	0
Dansk BoliByg	Conformists (if delivered more to the industry, they just complain why price was not lower)	2	Client gains, Value creation	2	0	0	0	0
	Human factor (one pm compared to other pm) we work with humans	2	Good relations	0	0	1	0	0

Figure	6.5:	Dansk	BoligByg	Issue	Summary
0			0,0		

The company Dansk BoligByg has the lowest scores within the *Diversification* and *Systems Thinking* pillars according to the analysis of the first interview. Thus the problems should correspond to these pillars, as it can be seen on the second analysis, the problems found and discussed refer to the pillars *Systems Thinking* and *Diversification*, in that order. There can also be seen a low value in the *Renewability* pillar, but this pillar, as explained previously, is not taken into account in the analysis and suggestion processes, as it refers to the company offices rather than projects, therefore, it is outside the scope.

Enemærke & Petersen

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.15*.

					Р	ILLAF	۱S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
Enemærke og Petersen	The whole idea would be to renovate or build new buildings, and actually offer the people who are going to maintain it, but the industry is not set up like this.	2	Linear, Contract	1	2	1	1	0
	We would like to have as much possibility to come in as early as possible	2	Contract Form	0	1	1	0	0

Figure 6.6: Enemærke & Petersen Issue Summary

The contracting company Enemærke & Petersen, has the lowest score within the *Systems Thinking* pillar, as well as in the *Recycling* pillar, where it is not negative, but neutral. Thus the problems should correspond to these pillars, but as it can be seen on the second analysis, the problems found and discussed refer to *Systems Thinking*, first and foremost, *Diversification* and *Optimisation*. This consideration of issues has a lot of influence from the industry itself, for the environment where companies are located has a direct effect on them. Therefore, if it is an industry wide problem, it is not always possible for one company to go around it. The suggestion portion of the thesis will take this into consideration, for the scope of this thesis is within the company itself, not external considerations.

MT Højgaard

					Ρ	ILLAF	۱S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	The safest approach is bullet first then cannons	2	Profit, Linear	2	2	1	1	0
MT Højgaard	Clients look at cost/benefit from 5- 10 years, but buildings life cycles are longer	2	Profit, Linear	2	2	1	1	0
	Subcontractors dont mention their innovative ideas to main contractors	2	Dialog, Collaboration Willingness	0	1	1	0	0
	Short-sighted ness	2	Profit, Linear	2	2	1	1	0

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.16*.

Figure 6.7: MT Højgaard Issue Summary

The contracting company MT Højgaard as analysed in the first round, has the lowest scores within the *Systems Thinking* and*Diversification* pillars. Thus the problems of the second analysis should correspond to these pillars. As it can be seen in the table the problems found and discussed refer, primarily, to *Systems Thinking* and then *Optimisation*. Therefore they don't directly correlate, but, this is part of the influence from the industry and the position of the company in the value chain. There can also be seen a high issue count on the *Diversification* pillar, which corresponds to the status from the first analysis, as the second lowest score. It is also important to state that the two main pillars that have issues are related, for suggesting solutions and tools in any of these will influence the other.

Scandi Byg

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.17*.

					Ρ	ILLAF	RS	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
ScandiByg	Its harder for a 'normal' contractor, who takes on main contracts to have any kind of influence on the client and project choices. It depends on the contract type	2	Contract form, Linear	1	2	1	1	0
,,,	For a normal contractor to reach circularity: There will be larger managing costs, more communication is needed, some sharply defined project, contracts etc.	2	Profit, Communication, Contract formulation, Tendering	1	3	3	0	0

Figure 6.8: Scandi Byg Issue Summary

The manufacturing and construction company Scandi Byg as analysed in the first round, has the lowest scores within the *Systems Thinking* and *Diversification* pillars. And as it can be seen on the second analysis, the problems found and discussed refer to the *Systems Thinking* and *Diversification* pillars accordingly. There can also be seen a high issue count in the *Optimisation* pillar, as with the other contracting companies, which points to the context and type of work that is related to this position in the value chain. This will be considered while undertaking the process of suggestions for solutions.

6.4.4 Clients

ALABU Bolig

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.18*.

					Ρ	ILLAF	۱S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Quality and risk of reused material	2	Quality, Distrust	2	1	1	1	0
ALABU	No feedback loops, they have a user board	2	linear. Processes, Dialog	4	4	2	1	0
	Hard to implement recycled materials, government must find a structure for certification	2	Profit, Linear, Distrust	3	3	2	1	0

Figure 6.9: Alabu Issue Summary

The public client Alabu Bolig has, according to the analysis of the first interview, the lowest score within the *Systems Thinking* pillar. But, in the issue area it can be found that there most issues correspond to the *Systems Thinking*, the *Optimisation*, and the *Diversification* pillars respectively. The suggestions will be targeted to fix these three issue areas, as focusing on creating solutions on one pillar, can prove to offer positive impact on the other pillars. This will be further explained in the description of the suggestions, and why those were chosen.

Søren Enggaard

The table below is a section of the problem analysis for the company. The full table can be seen in *appendix B.19*.

					Р	ILLAF	٢S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
Søren	Does not know of design for disasembly and material banks, lack of knowledge	2	2 linear. Processes			0	1	0
Enggaard	No processes for feedback and information sharing	2	linear. Processes, Dialog	2	2	0	1	0

Figure	6.10:	Søren	Enggaard	Issue	Summary
		0.01.011	21.00	100000	<i>c</i> umming

The first analysis of the client Søren Enggaard shows the lowest scores within the *Systems Thinking* and *Optimisation* pillars. While the problems discussed and analysed on basis of the second interview refer to *Systems Thinking*, *Optimisation*, and *Diversification*. This might seem counter-intuitive based on previous information, as the company looks for efficiency and profit where it can, but as this analysis

refers to *processes* the *Optimisation* pillar is focused in that area. It can also be understood that the *Systems Thinking* pillar is low due to the nature of the company business model, as it does not, directly, involve common procedures for projects.

The evidence in each individual analysis points to some trends within the industry. For example it can be seen that in the architecture companies the problematic areas are *Systems Thinking* and *Diversification* expressing the need to consider the bigger picture and the views and benefits of the other companies involved in projects. During the analysis another, more general, trend can be seen. The *Systems Thinking* and *Diversification* pillars are in every case contenders for the areas with the most problems. This further confirms the initial hypothesis and general issues discussed and found on all interviews. As, by this, it can be understood that the main problems in the industry refer to the distrust found amongst the different players, the high risk associated with trust-based work, but most importantly, the linearity of the industry.

The industry is very complex, due to the high level of specification of each project and the high capital requirements. Therefore, the default response seems to be, to solve the project, deliver and ensure that the company makes enough revenue to keep their head above water, nothing more. Nevertheless, during the interviews it was also seen that companies are getting more and more interested in circular economy, but are not necessarily sure how to achieve it to one extent or another, yet. Therefore, focus has been on suggesting practical, low-cost solutions. Furthermore, it must be understood that the edge, the values, and the business models of the company, must also be considered while developing possible solutions to the issues. Therefore, solutions are targeted to each of the interviewed companies and suggested in the hopes that the companies consider the implementation of them, to whichever extent they are able to. The implementation of solutions will solve part of the problems found and discussed, and this, in turn, will create a positive impact on the circularity of processes of every company. As a result of this, with every individual effort, the circularity of the industry will be improved.

In the next chapter the solutions will be further explained and offered in a way that is simple and effective if implemented.

Chapter 7

Bridging the Gap

Based on the interviews and the research performed into the circular possibilities, a number of suggestions for solutions to the established problems have been developed. These answer to the linear processes and the problematic collaborations in the industry. The solutions will be developed for the general issues and then cooperated with the specific needs and abilities of the different companies and company types. The suggestions are described and developed with the intention of outlining the potential of circular economy, and motivating companies to implement solutions that will yield company benefits on the short-term and long-term. The aim of this chapter is to outline these solutions and their connection to the established issues, to correlate the individual companies with specific steps towards circularity and, finally, to present these solutions to the relevant companies in order to engage the implementation of circular processes in the industry.

7.1 Industrywide Solutions

The first step which needs to be taken, in order for the circular model to really get a foothold in the Danish Construction Industry, is to establish motivational factors for the companies to adopt the model, and, secondly, to develop methods in which the model can be realised. Based on the issues outlined above, which were derived from the interviews with the companies, solution suggestions have been developed. These are split into three different areas.

One, is the motivational factors which require governmental or public interference. These are different steps which the municipalities, government or other entities can take in order to develop the motivation for circularity in the industry. Secondly, the interviews and the research uncovered that many issues, related to the possibility of implementing circular economy in the industry, lead back to the topic of communication. Therefore, the second area of solutions will be focused on bettering communication. Lastly, an area outlines the solution suggestions which are neither public motivational interference, nor communication based. These solutions are implementable tools and efforts which will improve the circularity of the industry. The solutions related to each of these three areas will be outlined in the following.

7.1.1 Motivation

The motivation can come from many different angles, but has to answer to the main concerns voiced through the established issues in the chapters above. Equal for all companies is that either motivation must come in the form of profitability, governmental pressure, or customer requirements. These motivational factors will create situations where companies will willingly and actively look into the development and usage of circular processes. Based on the interview data there is a need for governmental pressure in order to motivate the companies to work towards circularity. The public influence is, as mentioned, outside of the scope of this thesis, as the project focuses on the possibilities for the companies of the industry to further the circular economy. Therefore solutions suggested by the companies or found in the research, which requires public interference will be listed, but not further investigated. The steps which can be taken from governmental, municipal or other public side, in order to improve the motivation for circularity in the industry and minimise the gap between the current status and a circular economy, according to the interviewees, are:

- 1. **Increased Political Pressure** to create a pressure on all of the different actors in the industry. A pressure like this must ensure that all types of companies will focus on the development of circularity, as all actors are necessary if circularity is to be implemented.
- 2. Develop the Building Regulations in order to ensure equal terms for all companies within the industry in developing circular models, to create equal possibilities for companies to develop circularity, and additionally, to ensure the favouring of materials and processes which support a circular economy, rather than regulations shaped to the benefit of larger players in the industry such as concrete producers etc.

The regulations should be developed to include demands for disassembly possibilities and demands for the use of material passports, buildings as materials banks etc. for new builds, in order to ensure the reusability and recyclability of buildings and materials. And, finally, the building regulations should set out standards for what is circular or sustainable, within a system, for example a system relatable to that established for the energy usage of electrical products, making it easier for clients and end users to define their needs, and developers their products.

3. Improve Certification of Materials by developing more standards for which

materials can be reused, and how these can be certified in order to decrease risk for the contractors and clients in the use. Thereby, the possibility for usage of previously untested materials should be improved. Focus should be on a way in which the risk connected with the use of new materials is displaced from the contractor and client.

- 4. Funding for Innovation within the circular tools and processes will create incentives for companies to test new innovations and develop new circular processes and materials. Governmental incentives will create a monetary incentive for the companies and, additionally, relieve some of the financial risk connected with investing in the unknown. Additionally, there should be an increased focus on the topic in education within the industry, in order to create new ideas and to create a new generation of the industry with circular thinking as a key stone.
- 5. **Contract Development** within the industry could be improved through the creation of official structures which support collaboration in the industry. In addition to this, interviewed actors have pointed at the development of a frame for how a building should be left after the PPP contract, as a way of improving the sustainability and circularity of buildings. This should be achieved through a focus on the quality, the reusability, and the materials of the building on a more long-term basis.
- 6. Change of Public Processes, meaning the internal processes of the public clients and the financial pressure from the municipalities on the developing parties. The pressure on the profit margin should be decreased by changing the outlay of the current system of municipality trades with plots, a system which adds significant pressure to the costs of projects, as they have decision power at the start of the process (sale of plots) and the end of the project (demands to the rent amounts of the spaces). Finally, a reevaluation of the connection between *money to build* and *money to maintain* in the public sector is necessary in order to increase the focus on higher quality investments at the beginning of projects and to consider the full life cycle in the design of the building.

Each of these suggestions should be further researched in order to determine their effect, implementability, and cost. This is, as mentioned, outside the scope of the project and will therefore not be investigated further.

Once steps have been taken towards improving the motivation of the companies, the next thing to consider is the concern of how the circular processes can be achieved. Methods for how the companies can become more circular have to be developed with consideration to the current position of the companies and to the possibilities and limitations the companies are framed by.

7.1.2 Communication

An important factor in the development of the circular economy is the collaboration between different actors in the industry. Throughout the industry the way companies communicate with each other is seen as one of the biggest issues. The issues connected with this area, are so severe that it was touched upon in every single interview performed. Improving this aspect will in some cases be a matter of better real time information sharing and contact to the other actors involved. In other cases this will be a matter of better information sharing across time. Meaning sharing of information in regards to the materials and structure, and project in general between the actors designing and constructing it, and the actors using it, selling and buying it, and, finally, the actors demolishing it. With improved communication about the materials in the building and the use of the building, there will be an improved chance of optimal recycling of both the building and the building materials. The fact that all actors are pointing out issues in this area underlines the effect the bad communication has on all levels of project development in the industry. Therefore, this area has become the main area of development within this thesis. The possible solutions and considerations in regard to communication will be outlined in the following, they are divided into the following categories: Information Management, Collaboration, Standardisation and Strategy. The outlined solution categories are investigated and specific solution possibilities, which can aid the betterment of the categories, are presented in the following.

Information Management

This category evaluates how information should be attained, kept and shared in order to improve the communication with in the industry. Through this, the category connects to the pillars *Diversification*, *Optimisation*, *Systems Thinking* and *Recycling*. Diversification, most importantly, as it allows the company the ability to work with others and thereby improve the circularity of projects. Though less than this, the pillars optimisation and systems thinking are also affected through the possibility of improvement of processes and interactions between companies. And the *Recycling* pillar through the ability to reuse processes more efficiently. Below are outlined the specific solutions which aid the improvement of Information Management.

Internal Information Sharing

This refers to the communication channels within the same company, and, within the same, or different, department(s) in all branches of the company. With increasing the internal information sharing the communications, the understanding of what others do, and the internal processes can be established. In order to improve the communications to this degree the most efficient tool is the establishment of

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an open internal communication channel that receives and delegates updates and learnings. According to the *Project Management Body Of Knowledge* [24] this could be any of the following, or other, tools: notice boards, newsletters, annual reports, emails, team/group meetings, etc. A Communication Management Plan, which is a component of project management that explains how communications will be planned, structured, implemented and measured, would ensure that communication improves and that effective communication is achieved [24]. The most efficient tool is highly dependent on the type of company, the structure of the company, and even the layout of the working spaces.

Knowledge Keeping

In essence it refers to the ability of the company to keep, or absorb, the attained knowledge, and making it available within the company. The knowledge in question includes both that which is internally *and* externally obtained. Additionally, it includes tacit knowledge, which is often shared on a informal and inefficient level. The current issue is that the knowledge is, mostly, kept within the company by verbal delivery, and by the people who attained the learning. This means that at new employment, people leaving the company etc. knowledge will inevitably be lost. Through implementing this process in the company it should aid in learning from past experiences and not repeating mistakes. Most efficiently this can be executed by the development of databases of past projects and research, offering results and lessons learned, including key words marking main knowledge points. The first step of this approach is the standardised development of *Documentation of Learning* in the company.

This is the structured development of a documentation format which specifies the learnings from every project. The aim is to organise knowledge within the company and show the knowledge attained in every project by every area, expanding the company's expertise and problem solving speed and capabilities. The basis for this solution is a structured standardised frame, within which information is easily added and found, placed on a shared platform within the company where all have effortless access.

External Information Sharing

External Information Sharing is focused on increasing the communications and sharing of information with other companies in the industry. The purpose of improving this communication is to ensure that other companies are able to adapt to the processes of the company, and that the possibilities and limitations which exist within every company is understood by others involved. The improvement of this external communication can be established through an external grouped communication channel which shares the previous experiences and leanings from one company to the collaborators and other companies. This can be achieved through tools such as: Grouped newsletters, and folders with records. Also the principles of internal information sharing can be applied, but taking into account that the Communication Management Plan, will be unique to every project and must include the relevant information. The external information sharing can happen both during the project development and beyond in continuous partnerships.

Dialogue to Ensure Constructability

This method emphasises continuous communication back and forth between collaboration partners. The level of information exchange is higher than that which is obtained in simple External Information Sharing, as it requires either co-location or open communication channels between all actors. This creates a team, almost independent of the collaborating companies, but requires almost full time work from the involved parties in the project. This method is therefore only possible when working on large projects where most involved parties are involved full time. This should ensure a deeper understanding between companies of their individual processes and how these fit together, thereby limiting distrust and conflicts. Ultimately the aim is to include the entire value chain's point of view to solve problems before they materialise, and thereby ensure timely delivery of the project, trough lower mistake rates and less reworks. This dialogue can be attained through the use of, as mentioned, co-location, frequent in person meetings, shared models, early group integration; which varies for different players, but ideally includes all parties after the project conceptualisation.

Knowledge Integration

Knowledge Integration is about combining knowledge across companies, or departments, in order to create better and more efficient projects. The process can happen internally, within the same company, or in collaboration with other companies, dependent on the roles which the company maintains and which knowledge aspects are available to them. The idea is that when each actor involved in the process has the capability to consider not only their own perceptive, but also that of the other actors involved the overall project is improved. Essentially it is about a high level of information sharing, but combined with the availability of know-how and back and forth communication, creating as big a knowledge bank as possible. Therefore, the integration entails interdisciplinary collaboration. This means that it is necessary to create an understanding between all actors, which can be initiated by the creation of a shared dictionary, meaning that the same terms are understood and used by all; utilising the same classification systems, adding structure, and using ontologies to define models [5]. The best way of attaining this is to work at co-location with other involved actors and to thereby have the access to sharing knowledge continuously and instantaneously.

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Furthering Knowledge

Through structured knowledge sharing between different actors an improvement of the quality of the project should be attained. The main aspect of this concept is that knowledge should be shared, not only between the company obtaining the learning and the collaborating company on a project. But that knowledge attained by one actor, for example a contractor on one project, should be attained and delegated by the architecture company, as well as the contractor, to another contractor on a different project. This is done in order to delegate learning and attained knowledge as far in the industry as possible, and thereby strengthen the proof of feasibility and profitability of circular models. This aim can be attained through the development of documentation passed on through similar methods to what is outlined in the solution External Knowledge Sharing.

Shared Data Models

Applying a shared data model in a project has the purpose of ensuring that every actor understands what the project is, the goal of the project, the development progress, how the data is connected to each other, which information has to be shared (and at which moment), and the frames set by the other actors. The aim is to ensure that all involved actors have the most relevant information available at specific times, and that any changes made are instantaneously shared between the actors who need it for their work. Solutions such as a shared model can be used, the practice for creating shared models is to be practiced by sharing data and ensuring interoperability, workflow management, and other elements which are stated by the Building Information MOdelling book [5].

Post-Mortem Evaluation

The post-mortem evaluation is a meeting held after the completion of a project, which includes all parties from the project development. The project Post-Mortem is used to evaluate and analyse if elements of the project were successful or unsuccessful. This process is also known as Lessons Learned in the PMBOK [24]. The process diminishes the levels of risk on further projects, it provides the opportunity to capture lessons learned during the project, and to give feedback for improvement to other actors and within the company itself. Documenting and keeping this knowledge is an important part of the use of the post-mortem evaluation. It is attained through a meeting session and shared documentation where comments and learnings are noted.

Feedback Loops

Establishing feedback loops refers to the ability of the company to establish processes which record the results of activities and refer back to the group leader with the learnings. This is done with the purpose of offering data about results so they can be compared to the planned, and thereby improve on the preliminary processes by understanding the following. This can be achieved through the establishment of alternatives for capturing outcome information, for example customer satisfaction surveys, employee satisfaction survey, project meetings, and last planner meetings, amongst other alternatives, which allows for the incorporation of downstream information into the project team.

Collaboration

This category refers to an approach, where the value chain is considered as a whole. This means, that collaboration refers to the type of communication which takes place with other companies and to how the work on projects can be improved to produce optimal results. In this context collaboration connects to the pillars *Diversification* and *Systems Thinking*. Systems Thinking, primarily, as it allows the individual actors to see the value chain as a team for delivering a project, instead of different separate cogs in the process. This allows for the possibility of creating better relations amongst players and creating a team instead of a group. To a smaller extent the category also answers to diversification, as this refers to the augmentation of the opportunity to work with different actors in new ways which can result in better outcomes. The solutions in the following have been outlined by the interviewees and through research, and will aid the development of improved collaboration in the industry.

Collaboration Contracts

Establishing an element of collaboration as a standard element in the contracts the company works with will establish collaborative norms for the company projects. This will create a contractual agreement encouraging teamwork and collaboration between companies, thereby improving the trust and diversification. This approach will require the development of new contracts within the company, which includes clauses on the collaborative intent, requirements and frames for the company and their collaboration partners. The establishment of collaborative requirements in the contracts can be difficult, but may include financial incentives or other aspects which can be found in the standard for Partnering collaborations.

Partnering

Partnering is an project model where, as outlined in the subchapter *Project Types*, a partnership between two or more companies is established. Partnering is based on trust and openness, and in this project model different companies work as a single team with a common goal and common financial interests. In partnering one single agreement is made between all the parties in the project, rather than separate agreements between each of them, in order to ensure aligned interests in the project, which is what differentiates this project type from one where collaboration

contracts are applied. Through the early involvement of all the actors and the focus on problem solving, this project form provides an opportunity to improve the project through fewer conflicts and more trust between actors. Using this project type should create a better working environment which yield efficient and effective work. The partnering agreement can be applied to a project following any of the four contract types: Trade contract, Grouped contract, Main contract and Turnkey contract.

Facility Management Involvement

Creating a connection between the design team and a facility manager will allow the designers an insight into the use of the project after completion and a better understanding of the expected changes and problems that it may meet, through the use of feedback loops. This results in a more efficient design which prepares the building for the flexibility and changes necessary, improving the use of the building and the durability of the project. Considering the fact that the running and maintenance costs are on a longer time span than the construction, underlines why this approach is important for the project development. This connection can be established through the integration of facility managers as members of the design team, cross project meetings between facility managers and designers of similar projects, and established documentation systems communicating the feedback from facility managers to design teams. Other alternatives include utilising as built models as stated on Building Information Modelling [5], which will be used by Facility Managers to work on their practices. This process can also be found in the PMBOK [24], where the project manager includes the facility management as a part of the main project.

Initial Dialogue

Creating a dialogue culture for projects within the company and starting this from the project conception, has been found by companies to help ensure that concerns and ideas are shared and analysed from the beginning, resulting in the creation of better projects, where all parties are satisfied and understand the project expectations better from the beginning. Additionally, the group of actors become more of a team as trust and communication is increased. This is done most efficiently through in person meetings, working at co-location, and through encouraging opinion and idea sharing.

Physical Meetings

Establishing company processes of having in-person meetings regularly across the actors involved in the project will create a better work environment. Meetings will create increased idea exchange, bettering communication channels, and more trust between actors. As it has been found by companies in the industry, there is a larger

tendency for companies, which are meeting face to face, to be honest and not try to evade contracts etc. Based on the scale of the project these meetings should be held at semi regular intervals, but with more frequency in the beginning of the project work in order to establish the vision and agreements for the project.

Co-Location

Creating a single space where all the involved actors on a project are located together with the purpose of working on the project, will create an improved understanding of the other actors' perspectives, possibilities and issues within the project. This will improve the overall development of the project as less mistakes, conflicts, and disagreements will be created. The trust between the collaborating actors will be improved, as well as the broad perspective on the project, allowing for increased diversity. This means that this solution is only feasible when working on a larger project, or several projects, with the same involved actors. Additionally, a space has to be found for this collaboration to take place.

Shared Digital Models

Adding the use of shared digital models as a standard in the company processes will increase the efficiency with which information can be shared across the company and with other companies within a project. The shared model will ensure that every involved actor has the needed knowledge available at all times, and that the changes made are accessible to whomever may need them. With the use of a shared model clashes and issues can be easily and quickly identified. With the use of this process possible clashes within the design and development activities can be found fast and easily identified, limiting the need for corrective work later in the process. This means that using shared digital models in projects, as the norm, will allow companies improved communication and a better understanding of the processes of all the actors involved.

Standardisation

Concerned with the way processes, methods etc. can be standardised within companies, this category includes suggestions which will create more efficient work processes. The category mainly answers to the circularity pillar *Optimisation*, as a standardisation of the company processes will allow them to optimise the way the company works in projects and thereby limit the waste of resources connected with project development. The category also answers to the pillar *Recycling*, as it enables the reuse of processes, an underestimated side to the concept reuse, which improves the circularity in the company across projects.

Standardise Reuse of Processes

Reuse Processes is about creating frameworks for saving and reusing processes

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which have successfully been developed in projects. This means that when new processes have been successfully used in projects, knowledge is gained and this is used to develop standards for new processes which can be used in similar situations in the future. This is a way of ensuring that the company will continuously improve and build on top of what already is. For the company to achieve this, documentation and knowledge attaining activities, such as post-mortem meetings, must be put in place for the collection and storage of the information. This should result in a documented guide to follow regarding processes which have been developed in the company. Ultimately this approach should offer a better understanding of how to solve repeating issues, and how to cut down time spend on problems which have appeared previously.

Model for Right Time to Include Actors

The aim of this solution is to establish a standard for when is the optimal time for the company to involve the different actors they have to work with, in the development of projects. This means understanding at which point the company should optimally involve each of the actors to gain the needed knowledge and understanding in the project. Of course, the optimal time will differ based on the type of projects, but basic standards for when knowledge is the most valuable should be set up. Based on this understanding a standard should be created, for each of the actors the company collaborates with, so that in all projects the optimal involvement of actors can be achieved creating better diversification and systems thinking for the company. Through this approach the time dedicated by all parties can be optimised and it can be ensured that the sharing and distribution of knowledge and expertise of every player is utilised fully in the project development. The development of these standards should happen through the documentation of learnings gained in project development. This means trial and error, Work Flow Models, Business Process Model Notation, and other approaches can be used to analyse how the project will work and simulate the practice.

Involve the Contractor for Early Costs

This approach will allow the company, in this case, client, architect, or advisor, the ability to create a sense of security and trust within the project by involving the contractor early in the project and solidifying the budgeted costs of the project. This will limit the monetary risks connected with developing new, innovative and circular projects. Thereby making a more visibly feasible process.

More Defined Agreements

The most efficient way for the different companies to have less conflicts in the development of projects, according to the statements of multiple companies, is the development of more substantial and defined agreements between the parties.

Creating highly detailed agreements between each set of contractors in a project is a resource heavy task, which is also the reason this is not currently done in every project. Instead it is suggested that standardised agreements which can be applied to project after project, with no, or few, changes, are developed as part of the applied contracts. These should outline communication agreements, goals settings, etc. The development and use of these will create more precise and sharp contractual agreements, resulting in easier collaborations and a higher level of trust in the project development process.

Strategy

These solutions are focused on the strategy behind communication with the intent to sell projects and guiding clients towards a more circular process and project. It does not refer to a company's strategic intent in the industry. The category mainly aids the improvement of the pillars *Diversification*, as it enables the company to branch out and become more resilient through different types of projects, and *Systems Thinking*, as it focuses on how to include the client as a part of the value chain and, through this, influence the entire system. Below are outlined specific steps which can aid the improvement of these factors.

Client Workshops

Client Workshops are meetings between the company and the clients, where the clients get a better understanding of what the project is, what the company does, how this can improve the project, and the broader view on the project as seen from the perspective of the company. The goal is to ensure that the client understands the goals and principles of the project, as well as the limitations, but more importantly, the possibilities connected with the project. This goal is achieved through meetings between the client and one or more of the involved companies in the project development.

Promoting Without Saying Circular Economy

This refers to developing a strategy where circular economy can be implemented based on other viewpoints than a sustainability focus, showing the potential from other angles, such as profit, and long-term benefits. In some cases it is about offering different viewpoints which showcase other elements ahead of the sustainability aspect, since the term *Circular Economy* is sometimes shunned due to misunderstanding, or lack of interest from the client. The idea is to focus on the benefits of circular economy as a whole, where all the pillars are strengthened and benefits can be reaped. This would mean that the benefits gained in the project through diversification, better systems thinking etc. are presented as value creation for the client, rather than the words 'circular economy' or 'sustainability' which are often associated with unnecessary additional costs. This can be achieved by offering

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simple calculations, numbering benefits, long-term understandings of projects, and any other positive effects of working within circular economy, offering the sustainable side of the concept as added value, and not as a selling point.

Develop Proof of Profitability

The most efficient motivator to convince companies to take steps towards circularity in the industry, as found in the interviews, is to develop proof of the profitability of the circular processes. This means being able to show companies how they can benefit from implementing circularity into their project development. Most efficiently, proof is gained though the recording of the development and running of successful projects. Additionally, this can be done by creating calculations on the long-term costs, the maintenance efforts, or even by considering the project as a material bank which can be resold after its initial life cycle is completed. Through these means the proof of monetary and resource profitability of the processes can be provided to the other actors.

These measures include the use of different points of view and creativity in order to prove that the application of circular models is profitable to the other actors, as well as the client, in the project; that the implementation of circular processes will be a benefit, not a hindrance, for them. Depending on the type of actor the focus is on different aspects is needed: If a client is to be motivated looking at the minimisation of long-term costs makes sense. However, if a contractor is to be convinced, focus on the resource efficiency, for example though the minimisation of reworks, is valuable.

Promote Your Circularity

A business model, which works for some companies interviewed in the project, is to use their sustainability and circularity to promote themselves in the market. This aids the marketing of the business and allows them an advantage in the current market where there is an increasing focus on sustainability. This approach is especially useful for companies, who, without a sustainability focus, are already applying methods which, by default, are circular or sustainable. The promotion of this aspect can be achieved through an increased focus from the company, through the presence at sustainability focused markets, and though networking in communities such as the NBE.

Challenging Customer Needs

The companies involved with the client of the project can, through different methods, attempt to sway the customer's requirements in different ways. One aspect of this is to attempt to create a more long-term view on the project. By making the customer consider the long-term use of the project rather than just the immediate need, the project will become more circular through a design for: long-term use, changes in usability, and disassembly. Presenting cases of similar projects and their long-term uses and necessity changes, can be used to challenge the customers' ideas of their needs for the project, thereby creating more long-term and holistic solutions. The company can attempt to reach and sway the clients through meetings at the beginning of the process, workshops, offering alternatives, showing their previous portfolio, establishing effective communication, and creating a base of what the context and concept of the customer needs are.

Net Present Value Calculations

To convince clients to make choices which fit with the aim of the company, an efficient way to influence the client is to make simple, meaning using little time and few resources, NPV calculations, which should provide the client with a better understanding of the overall effects of decisions, and may therefore sway them towards a more long-term view. These simple calculations will help present the complete life cycle costs of the project to the customer, as opposed to the usual focus on the construction costs. These simple calculations allow the client to see how choices impact the costs of the building, to consider current interest rates while evaluating projections, to understand that a project will become an asset, and that decisions which are currently being incurred will offer future monetary benefits, and to what extent.

Instil Trust by Using Same Teams

Improve the trust between the different actors in the industry, when working with repeating customers or companies on projects, by maintaining and connecting the same teams to the same clients and other collaboration partners. This creates a more united feeling between the teams of the different companies and thereby increases the sense of trust between the parties. This is because an increased time-frame for the team existence will enhance the development of high performance teams. High performance teams are more productive and work with a greater level of success than regular teams or groups. Therefore, will there be logistical benefits to the development of these. Additionally, if a project yielded positive results, offering the same or a similar team will allow the client to set the standard for what is needed in the project development, as well as having a better notion of what will be delivered, and in which manner. This measure allows the client to create better forecasts for themselves, and for the company to build stronger rapport with their clients.

Develop Proof of Feasibility

It has been pointed out by different actors in the industry that one of the biggest motivators for developing on the circularity concept would be an insurance that these processes would actually work and be beneficial for the company. Through

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the proof of feasibility other companies will be motivated to follow along the processes lain-out and develop the circular economy as well. Creating portfolios of developed projects and examples of successful project developments will be one of the easiest ways for the companies to develop this proof. However, developing these takes time, as the proof must come in the form of much more long-term perspectives than what is readily available. This means that observations of feasibility might have to come from looking at the full lifetime of a building. But, it can also be focused on proving the feasibility of smaller elements, and developing other project using these.

Life Cycle Analysis

The Life Cycle Analysis (LCA) is a tool which allows one to consider the full life cycle of a material, with focus on the environmental impact, when deciding which to apply in the project. The LCA considers the complete environmental impact, from material extraction to the material is returned to the earth, providing an in-depth understanding of the product at its full. Through the four steps: Goal Definition and Scoping, Inventory Analysis, Impact Assessment, and Interpretation, an inventory of the inputs and outputs of the product life cycle, and evaluation of the impacts and an interpretation of the results is developed. The purpose of using this tool is to allow for a better informed decision regarding the chosen materials and their full life time [10]. An LCA can be made of different materials and these can be compared in order to determine which of the possible choices will be the most beneficial for the project.

7.1.3 Industry Efforts

The last area is, as mentioned, implementable solutions which will aid the circularity of the industry. These are implementable solutions which can be applied in either the different companies, between companies or in the industry overall by the public entities, in order to further the circularity. These solutions are concepts, tools and processes which the companies within the industry, in accordance with the sample, sees potential in or need for. The solutions are partially or fully developed and provides the companies with concrete steps to take in order to improve the circularity of their projects. In order for these solutions to work optimally, and produce the intended benefits, the communication in the industry must first be improved. So while the implementation of these is necessary in order to reach circularity, the focus for now remains on improving the circularity of the industry through the development of the communication within. Ultimately, these solutions fall outside of the scope of this thesis, as they require a joint effort within the industry and can not be implemented by one company alone, and be expected to work. The solutions outlined through the interviews and research are listed and briefly explained in the following:

• Design for Disassembly

Design for disassembly is the concept of designing and constructing the building, or project, with the ability to be disassembled at the end of its life time. Whether the disassembling results in the same building being reconstructed elsewhere, or in the materials being separated and reused and recycled depends on the intent at design. The aim of this process is to maintain the value of the materials and the ability to reuse them at the highest level.

• Design for Change / Design for Flexibility

Designing with the intent of having the project change whenever needed throughout its lifetime. Through this the duration of the project will be extended allowing for a high level of circularity. This is already applied in the industry, both by clients and designers who recognise the benefits connected with forth-sighted design.

• Material Passports

The traceability of materials is important in order to be able to better recycle and reuse them. Through the material passport an increased understanding of the abilities, qualities and placement of these materials will be increased.

• Buildings as Material Banks

Constructing buildings which are intended to be disassembled and reused for other projects. This allows for a better recycling and upcycling of the materials at the end of the life time of the initial building. In this process a building is looked upon as a source of materials (such as a quarry), as it fulfills its life cycle. The success of this method demands that actors across the process work together.

Material Input

The input of used materials back into the industry is an important aspect of developing the circularity. This is an aspect which is at the base of the circular economy, as without the input of materials, there will be no reuse. This again an aspect which demands several actors to collaborate.

• Material Matrix

A matrix describing the product, the cost of disposing them, and the cost for carefully harvesting the material, and an expected market price for this material. The development of a matrix like this will encourage the reuse of materials. The company Enemærke & Petersen has in a research collaboration started the development of a matrix.

Material Databases

Databases of the reused and recycled materials are necessary to empowering

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the circular market. It is necessary for the companies in the industry to be able to see which materials are available, in order to develop projects with these.

• Quantifying the SDG's

A tool for quantifying the SDG's is a way for companies to better understand how they can emphasise the sustainability of projects. The company Niras is doing an internal tool for this purpose.

• Modular Building

Modular construction provides the possibility to develop circular projects which can be treated as disassemble or temporary.

• Temporary Construction

In order to develop the circularity of projects in locations where the future might include high levels of change, designing temporary constructions which are either modular or otherwise designed for disassembly, rather than creating a need for untimely demolition.

• Include Total Economy

With the inclusion of the total economy, meaning construction, running, renovation and demolition costs, in the conception of the project circular processes will be improved.

• Storage Facilities for Recyclable Materials

To solve the large issue with the logistics connected with the acquisition of materials and the storage, transport and location of materials between the time of demolition and the time for use in a new construction. The development of an infrastructure which will aid this problem, for example in form of available storage facilities, will decrease the risk connected with developing projects utilising recycled materials. This is being implemented by big public clients such as the municipality of Copenhagen.

A consideration which should be made in regards to the implementation of solutions for the improvement of circular economy is whether the solution will create more circularity at implementation, or whether it will create a higher level of circularity in the future. Some solutions are focused on the implementation of frames and measures which will ensure a more circular future. Considering the long lifetime of the products that this industry produces, this future may be far from the current time. But this is exactly what makes it imperative that measures are taken to improve the circularity now: Changes made now will have affect for 30, 50 years or more. The outlined solutions are, mostly, widely renowned and talked about in the industry, but, as mentioned, require parts of, or, the whole, value chain to act as a team, which is not the current situation. Therefore, when the solutions regarding communication have been implemented, or the industry works as a whole, then these solutions would be the next step towards a circular industry.

7.2 Suggestions for Companies

In this subchapter the solutions outlined in subchapter 7.1.2 are applied to each of the interviewed companies. Focus is maintained on the type, position and understanding of the individual companies. Thereby solutions which take into account the concerns voiced and the opportunities established for each company are provided. The communication solutions will be recommended to the companies with consideration to the issues each company faces and which solutions might aid their circularity and help them close the gap between the current position and a more circular future. As the solutions chosen for each company are based on the circularity pillars in which the company can improve their processes the most, the solutions connect back to the initial analysis performed.

The recommendations for steps which can be taken by the companies are based on the knowledge developed of the different companies through the interviews. These recommendations are not all of the possibilities available to the companies, for more, the categories connected to the pillars which are wanted improved can be looked into. However, the solutions recommended are those which are estimated to best connect with the goal set for the company and the current status of the company based on the researchers' understanding. Furthermore, the solutions are thought as the initial steps for the companies. Not as the complete road to circularity. The companies, or any company, can look into the full list of suggested solutions in order to develop their company differently, or more towards circularity, once the initial steps have been taken.

7.2.1 Architects

Lendager

Lendager is a more circular company than what is generally seen in the industry. However, regardless of their circularity the analysis performed also shows areas in which they have the possibilities to improve their circularity and benefit through the implementations of the related solutions. As the analysis shows the pillar with the lowest score for the company is the diversification pillar. This is because the company, as a front runner, loses some of the possibility of collaborating with, and learning from others. Additionally, the pillar *Systems Thinking* is the second to lowest pillar for the company due to the willingness of other companies to work in this type of project, and trying to shift focus onto other areas. In order to improve on these areas, the company should focus on the solutions connected with the *Diversification* and *Systems Thinking* pillars. This means the communication

categories: Information management, Collaboration, and Strategy. The measures which would aid the company within these categories, based on the collected data from the interviews and the research are:

- Knowledge Keeping: The company will benefit from this measure as it provides a missing ability to store knowledge within the company, independently of the employees developing the knowledge.
- Knowledge Integration: Including the perspective from contractors and other actors earlier in the design process, will allow the company a deeper understanding of the possibilities and make the contractors more agreeable.
- Furthering Knowledge: The sharing of knowhow from one contractor, for example, to another, on how to execute building processes, will serve as a proof of feasibility for the contractors the company is collaborating with. Thereby, improving the collaboration on the project.
- Post-Mortem Evaluation: The inclusion of meetings after completing a project, will help spread the knowledge of lessons learned and what alternatives can be used throughout the company. It also supports the *Furthering Knowledge*, for it connects the internal and external knowledge.
- Develop Proof of Profitability: Present long-term costs Vs short-term costs, and show the impact of the choices presented, this will allow the customer to have a long-term view of projects. *Net Present Value Calculations* presents a simple calculation that will create the proof, and will further the process of convincing the client that a project can be more profitable if certain solutions are chosen.
- Develop Proof of Feasibility: Having a method to show past projects which are sustainable and company collaborations (with different players, including the ones that are not sustainably focused), as well as proven and successful previous processes, will aid the reputation of the company and the validity of the methods used, as well as the results obtained.

With the implementation of these solutions in the company, the circularity will be improved. This will mean a more circular company and processes. As Lendager is already a front runner in the industry with regard to sustainability and circularity, this will empower and solidify their position and the benefits gained through this process.

LINK Arkitektur

LINK Arkitektur is an established and big architectural company, with many years of experience. This experience has created the possibility for the company to be

differentiated by their knowledge and expertise. This also means that their usually customer group is expecting a very specific area of knowledge from them, minimising the incentive for the company to branch out into new knowledge areas and new processes, such as circular economy. Because of the focus of the company, the analysis performed shows that the company is excelling in the circularity pillar *Optimisation*. The analysis also shows that the pillar in which the company has the biggest potential for development is *Systems Thinking*. Therefore, the focus on suggestions for the company should be on the solution categories which answer to this pillar. These are: Information Management, Collaboration, and Strategy. The suggested solutions for the company to improve their overall circularity are:

- Knowledge Integration: The company can benefit from applying knowledge integration into the development of projects because of the deeper understanding of other actors' processes and concerns this will provide. This means that design with a higher level of constructability can be accomplished, based on the communication between the actors. The company already has a level of knowledge integration with the manufacturing companies they work with in the development of design, this can be expanded to the inclusion of contractor knowledge in the design process, as this will improve the systems thinking in the projects.
- Feedback Loops: The feedback loops are an aspect which the company is already working with. This can be standardised, and processes for how and when this information is collected and delegated can be developed with great improvement to the holistic approach towards projects in the company.
- Collaboration Contracts: Developing a standard for using collaboration contracts in projects will change the way the company communicates with other companies. The standards for exchanging information will be sharpened, and more efficient processes can be developed. The collaborative aspects of the contracts include incentives for the different actors to work together, improving the diversification in the project.
- Shared Digital Models: Sharing digital models with the other actors involved in the project is a way for the company to improve the productivity and resource use of the employees. It means continuous updates from the other actors and constant access to the changes made to the project. This will result in less rework and fewer misunderstandings and mistakes for the company, increasing efficiency and the systems thinking in the project.
- Challenging Customer Needs: Many customers have trust in the knowledge and decisions of the company based on the reputation and expertise of the company. Therefore, the company is able to influence the clients more efficiently than some other companies in the industry. With this knowledge and

expertise the company is able to challenge the needs of the customers and sway them towards more circular projects. This includes pushing the ideas of design for change, design for disassembly, and buildings as material banks as it fits the shape of the project.

- Net Present Value Calculations: Preparing simple net present value calculations to the alternatives in the design of the project can be a helpful tool for the company to showcase the effects of the decisions made by the clients, and, thereby, sway the clients towards making more sustainable and circular choices wherever these may also be more profitable. The NPV calculations are especially a helpful tool for the advisory part of the company.
- Life Cycle Analysis: Applying a life cycle analysis to the products designed into the project will allow the company to provide the client with a more full understanding of the sustainability of the project. This can be a helpful tool in including the materials wanted into the project and swaying the clients towards more sustainable choices.

The implementation of these processes will push the company towards a more circular model, without altering the focus and business model for the company. This means than when the industry, as a whole, moves to be more circular the company will still be in a strong position within the market.

7.2.2 Engineers

Niras

Niras is an engineering firm with a focus on efficient projects and new knowledge. During the analysis, areas where improvement can be made, in regard to their circularity within processes, were found. This circularity can be improved through the solutions presented. As it is shown in the initial analysis, the pillar with the lowest score of the company is the *Systems Thinking* pillar. This is because the company, loses some of the potential to be involved in further processes regarding projects. Additionally, the *Diversification* pillar can be further improved, for it is to some extent connected to the previously mentioned pillar. In order to improve on these pillars, the company should focus on the connected communication categories. The measures that can be targeted in this case, based on the interview data, are:

• Internal Information Sharing: the company will benefit from this measure as it provides the establishment/improvement of communication channels within the different departments of the company. For they share information amongst players, such as Project Managers, but the whole company within project development should receive such information as to understand what is being done in other projects, which allows for faster project solution development and lowers the likelihood of repeating mistakes.

- Knowledge Keeping: this measure allows the company to store knowledge within the company, from current and previous projects, thus allowing employees to access past experiences and further company knowledge base, independently of which employee develops the knowledge.
- Collaboration Contracts: the company may benefit from establishing an element of collaboration as a standard of how the company works. This enables the company to encourage teamwork and collaboration within projects which in turn improves trust across projects.
- Facility Management Involvement: the involvement of Facility Managers with the design team will allow the project leads to get information feedback regarding possible solutions to be implemented in design which offers more flexibility and improves the durability and performance of a project.
- Develop Proof of Profitability: presenting long-term cost vs short-term costs and the impact of possible solutions, as well as ensuring that the customer can see the project as an asset rather than a cost, might motivate them to choose better, and more sustainable alternatives.
- Reuse Processes (standard): the standardisation of company processes, regarding projects, when it is proven to yield positive results, will allow the company to ensure that projects are developed in a similar manner. This also strengthens the company knowledge base for new hires, and bettering project development times.

The implementation of these suggestions will make the company processes more circular, without altering the focus of the company, it also doesn't require a high capital investment. This prepares the company and positions it better when the industry becomes more circular.

7.2.3 Contractors

Dansk Boligbyg

Considering the fact that Dansk Boligbyg is a purely management company, the company has collaborations with many of the actors in each project. This enforces the importance of having good communication processes in the company. The analysis performed outlines the areas in which the company has the biggest potential for improvements. The lowest pillars in the company are the *Systems Thinking* and *Diversification* pillars. In order to improve these areas, focus should

7.2. Suggestions for Companies

be on the communication categories: Information management, Collaboration, and Strategy. The measures recommended are:

- Internal Information Sharing: The development of projects can be made more efficient and profitable, if the internal information sharing is developed to a point where not only the individual departments are sharing information within, but information is also shared more freely between different departments. The development of an information sharing protocol within the company will mean that mistakes will only be made once, and that successfully developed processes can easily be copied and applied in other projects. The first step for successful internal information sharing is the development of a Communication Management Plan, which will frame how to communicate within the company.
- Knowledge Keeping: Keeping the attained knowledge within the company, in a system which is easy to both add knowledge to, and locate knowledge through, is an essential part of optimising the processes in the company and ensuring that any learnings attained in the company, also stay in the company, independently of individual employees and projects.
- Knowledge Integration: The integration of knowledge from other companies, especially sub-contractors in the development of project can be a great asset to the company and their development of projects. The company already uses some of this in their early inclusion of subcontractors to help determine price of the projects. This can be increased with the inclusion of knowledge of constructability and construction processes. The company will benefit from this through the improvement of understanding of the full processes of the project and the collaboration with other companies, creating more goodwill between the involved actors, and thereby easier communication. Developing Documentation of Learning is the first step in ensuring this.
- Shared Digital Models: Both the *Systems Thinking*, and the *Diversification* of the company can be improved through the use of shared digital models. These models provide the company with an understanding of the developments and changes to the projects in real time, which increases the agility of the company and their possibilities for improving both the *Diversification* and the *Systems Thinking* for the company, therefore, the application of these models should be standardised within the company.
- Collaboration Contracts: The use of collaboration contracts will improve the diversification in the company, as it creates a more solid foundation for the communication and knowledge sharing between the involved actors. As the company is solely doing the management of the project and hiring other companies to perform the constructions, there is an increased possibility for profit

in having the subcontractors work with the company, rather than against, as this can improve efficiency of the work (through less rework etc.) and decrease pricing.

The solutions suggested are all focused on creating more circularity for the company, while being light in resources and costs, in order to make them more implementable. The company will be able to improve their processes, and thereby circularity, with the implementation of these suggestions.

Enemærke & Petersen

Because of the focus within the company on social sustainability and communication they have very high levels of circularity compared to the industry as a whole. As can be seen on the analysis, the company is especially strong in *Diversification* and *Optimisation*. This leaves the remainder three pillars: *Systems Thinking, Renewability* and *Recycling*, as the areas in which actions towards improvements should be focused. The communication categories which answer to these are: Information Management, Collaboration, and Standardisation. The following suggestions are therefore focused within these:

- Internal Information Sharing: Through developing solid processes for how information should be shared within the company more efficient communication can be achieved internally. This should improve the development of projects and the processing of learnings from one project to the next. The more efficiently the information needed is shared within the company, the more value can be created for the projects and the better the systems thinking and the recycling of processes. The development of a Communication Management Plan should be the first step in improving this area. As the company works in partnerships and on co-location, they have the opportunity to attain large amounts of knowledge externally, spreading this within the company is especially important.
- Knowledge Keeping: Once the knowledge has been developed or absorbed in the company, what's important is to keep said knowledge and to keep it available to the employees who may need it. With the development of a structured frame for keeping the knowledge, such as Documentation of Learning, the attained knowledge, both internal and external, tacit and realised, can be saved inside the company. This will help the company's ability to recycle processes.
- Furthering Knowledge: Through the ability to gain knowledge at one project from the collaborating parties, and transfer this to other projects and other actors who may be in similar positions, the company will improve their ability

to look at the project as a whole and thereby the pillar *Systems Thinking*. This is especially interesting for the company as they work in strategic partnerships and work on co-location, and thereby have the ability to obtain larger amounts of knowledge from many different actors.

- Post-Mortem Evaluation: The Post-Mortem meetings can aid the collection of information about projects. The aim of this is to improve the company understanding of the project process as a whole, and thereby, including all actors and phases in the considerations regarding the project. Collecting, sharing and keeping this information will improve the pillar *Systems Thinking* for the company.
- Reuse Processes: Developing standards for how to reuse processes on projects within the company will strengthen the pillar *Recycling*. It is about creating processes which can be applied again and again, and thereby perfecting the way the company approaches projects and collaborations. Thereby creating more efficient and circular processes. The development of this solution is dependent on the use of Post-Mortem Evaluations, as the information gathered in these lays the ground for the development of recyclable processes.
- Develop Proof of Profitability: As one of the focuses of the company is to push other companies to want to, not only work with them, but work towards their sustainability causes with them, a lot of focus has to be kept on motivation others to accept these processes. One of the ways to do this is to develop proof, within projects, of the profitability of the measures used. This means, attaining information on developed projects which have been successful, and applying this to new projects and new actors, in order to convince them that following the lain-out processes will result in profit. A difficult and important aspect in the development of motivation in this profit focused industry.
- Develop Proof of Feasibility: Similarly, can proof of the feasibility of suggested solutions or processes be a huge asset in convincing other actors to work alongside them on projects and, especially, on new innovative methods and processes. The proof of feasibility must be gathered through the recording and categorisation of developed projects, showcasing that the methods used were possible, and effective.

By implementing these solutions in the company, the circularity will be improved. This will mean a more circular company and processes overall. Based on the high level of sustainability of the company already, and their focus on communication, these suggestions are steps which can be used to solidify their position, and to push other actors to follow in the direction of circular development.

MT Højgaard

MT Højgaard is a contracting company with a wide range of expertise and a complex portfolio. During the analysis it was found that there are some areas which can be improved regarding the circularity in their processes. The pillars that present the lowest score of the company is the *Systems Thinking* pillar. This is because the company loses some of the potential to be further involved in processes regarding projects. The second lowest score belongs to the *Diversification* pillar. In order to improve on these pillars, the company should focus on the solutions connected to these. This means the communication categories: Information Management, Collaboration and Strategy. The measure that can be targeted in this case, based on the interview data, are:

- Furthering Knowledge: since the company works with different companies and players on each project, and also subcontracts other companies for big projects, it is possible to widen their knowledge base and allow for better collaborations by passing on information or lessons learned between the different companies, for example if a carpenter is hired for a project and there is a lesson learned, when starting the next project, the learned processes from the previous experience can be passed on to the new subcontractor, thus bettering the processes with different companies.
- Shared Data Model: when entering different projects, sharing data models regarding what the project is, the goal, and the frame-sets (all done by understanding the type of data that will be needed and implemented) helps the contractor and other players work within the design development, allowing for easier collaborations between different players.
- Post-Mortem Evaluation: when completing a project, it is important to record the lessons learned from all parties involved to analyse the good practices and the unsuccessful solutions, this lowers risk on other projects and it can give feedback on improvements, or areas that can be improved upon, from one project to the next.
- Co-Location: due to the size of the company and complexity of the projects, it is recommendable to consider the co-location of teams for projects Here communication is enhanced and it allows the possibility to offer opinions first-hand and talk about project outcomes and decision consequences. The location of a project team with other companies in the same space can enhance the holistic view of the project and other player concerns.
- Net Present Value Calculations: during the presentation of a solution regarding sustainability or circular economy, clients might shun away the circular alternative as it is associated with higher costs. But, if as suggested, a simple

calculation regarding the net present value of the investment with current interest percentages, will show that the current cost, is an asset rather than a cost, for it will offer better results and can even make the project more profitable in the long-term, this could sway the clients.

• Instill Trust by Using the Same Teams: this is a way to tackle the trust issues within the industry. Assigning the same team to repeating clients, on the basis that the previous business was a success, can make the client more willing to choose the company for it offers a sense of trust based on previous experience. It also allows the customer to forecast what can be expected of the project and in which manner it will be delivered.

These suggestions will push the company and other players involved into a more circular model, which will yield positive results in collaborations and trust. Thus making the company and the industry more circular regarding the internal processes.

Scandi Byg

SandiByg is a modular manufacturing and contracting company with unique knowledge within the modular construction industry. During the analysis it was found that there are areas for improvement regarding their, already somewhat circular, processes. This can be improved through the solutions presented. As it was shown in the analysis, the pillar with lowest score was the *Systems Thinking* pillar, followed by the *Diversification* pillar. This is due to the linear thinking of the industry and the difficulty in working on every project due to the modular building capacities and characteristics. In order to improve the stance on these pillars, the company should focus on solutions that are connected to solving these problems. The suggested measures are as follows:

- External Information Sharing: creating more emphasis on increasing communication and sharing information with other companies in the industry regarding their processes, and products helps the spreading of information and for companies to adapt to their processes. The more it is known about these processes and products the more interest there will be in utilising such solutions.
- Knowledge Integration: the combination of knowledge across companies, specially with an external company approach enable a better collaboration that takes into consideration external perspectives. This can help the company get a better idea of what other companies need, how they work, and help with product development, as well as offering the company's point of view and know-how in order for other companies to understand their products.

- Collaboration Contracts: this can be used as the standard element that will help establish norms for company projects. Thus enabling teamwork and collaboration across companies and creating a new level of trust and diversifying the company projects.
- Client Workshops: offering and presenting client workshops, enables the company to showcase their products regarding their possibilities, flexibility and opportunities. Having a customer who is more educated on your products enables a better understanding of the project and possibly extends the added value of the products.
- Promote Your Circularity: the company already has some circular processes and product capabilities as well as offering the *Svanemærke* label. And even though sustainability is not in every project's goal, promoting the company through these methods can be highly beneficial, considering that the modules entail a disassembly option on the long-term. These qualities add an edge to the product and the company which seems underestimated, but can yield highly positive effects and alternatives for future projects to come.
- Challenge Customer Needs: the customer is not necessarily an expert in the field of the wanted project, therefore it is important for the company to ensure that the customer understands what the company can do for them, as well as offering alternatives to the initial project that might aid the efficiency or long-term view of the project, the flexibility presented with the company products offers an edge that can be further exploited for the benefit of the company, project and client.
- Instill Trust by Using the Same Teams: offering recurring customers the same or a very similar team to the previously assigned to their project instills trust in the customer which enables better working parameters as well as comfort on the client side. The client can better forecast what is to be delivered and in which manner. Thus, creating more trust in the company and the project.

By implementing these solutions the company will create an even more solid foundation of knowledge and attract more customers based on collaborations and trust. This will further solidify their position in the market as well as prepare the company for future circularity modifications that may come into the industry.

7.2.4 Clients

ALABU

Based on the models that the company works within, mainly focused around the frames that comes with being a public client, the pillars show that where the most

can be gained from changes are the pillars *Systems Thinking* and *Diversification*. In order to develop these areas the communication categories: Information Management, Collaboration, and Strategy should be looked at. Within these the solutions chosen for this company are:

- Furthering Knowledge: When working with main contracts the client is directly involved with the contractor in charge of the execution of the project. This means that they have access to the information and the learnings which the contractors gain through the duration of the projects. The gathering and delegation of this information to other contractors in other projects, which may include similar challenges, will improve the project development, as risk will be reduced for the contractors, and thereby the profit margins can be limited as well, creating cheaper projects. It will create a more holistic view on the projects which are developed and thereby aid the pillar *systems thinking* in the company.
- Collaboration Contracts: The company currently works with main contracts in order to maintain more control, for longer in the process, in regard to material and process choices. As it has been pointed out, this contract form results in many difficult contact points, therefore, it can be recommended, that the company develops a standard for using collaboration contracts in projects. This will change the way the company communicates with other companies, the standards for exchanging information will be sharpened, and more efficient processes can be developed.
- Facility Management Involvement: Creating standards for the feedback about the development of the projects from the facility managers will help the company make better decisions in regard to which materials should be included in the projects and, more importantly, which should be excluded. The private client interviewed outlined the importance of this information as it allows them to invest in the quality of the right materials from the beginning, significantly limiting the cost of maintenance in the future. By including this perspective it allows the company to improve their *systems thinking*, by including the full project lifespan into the initial considerations.
- Physical Meetings: As stated by the other interviewed client, having physical meeting and initial dialogues with the other involved actors is the best approach to control the project. This will create a frame for the company where they can improve the diversification of the projects, while not letting go of the needed control of the project development.
- More Defined Agreements: Developing solidified agreement between the different companies involved in the project is the best way for the company to

ensure that all of the specifications to the projects are upheld and developed according to the requirements. As confirmed by the private client in the interview group, it is the development of such agreements what allows them high levels of control with the use of the least amount of resources. Setting up standards for more detailed contracts which can be applied in most projects will aid the diversification of the company.

• Net Present Value Calculations: Considering the fact that the company has interest in becoming the most sustainable in northern Jutland, this focus must be maintained within all decisions the company makes to make it a reality. However, the company answers to the boards of customers who have the highest decision power in the company. This means that when circular, or any, measures are to be taken, these have to be convinced that the presented solutions are both profitable, feasible, and appropriate for the project. In order to create an easy way to look at these decisions, the company can use the development of simple NPV calculations to show the value of the decisions the company is trying to push. This will create substantial and tangible alternatives for the customers to consider and base their decisions on.

Through the implementation of these processes, the company will become more circular, and will be able to push the project decisions towards more circular alternatives.

Søren Enggaard

The client Søren Enggaard focuses on profitability and selling at competitive prices. During the analysis it was found that there are areas regarding circularity which can be improved. The pillars with the lowest scores are *systems thinking, optimisation* and *recycling* respectively. This is due to the perceived detachment from the value chain and system, processes and linearity. These pillars can be improved by targeted measures, based on the interview data:

- Knowledge Keeping: even though, as previously explained, the number of workers in the company is fairly low and communications are mostly direct, it is important to record the knowledge gained, in case the work group grows, or a company member leaves the office, in this case the knowledge will still be available for the next projects. Offering this possibility will speed up project decision as well as widen the knowledge base of the company
- Knowledge Integration: This is about reinforcing the knowledge acquisition of the company, by integrating the knowledge they have acquired and the knowledge of other companies, who they collaborate with in different
projects, into the project processes. In this case, it is suggested to do this work both internally and externally, with the other companies who they are collaborating with to expand the knowledge base, which optimises the company projects in the long-term.

- Post-mortem Evaluation: undertaking a lessons learned meeting at the end of every projects, is to be a simple task, for the size of the company allows the teams to get together and receive the knowledge first hand, of what was done in a project, with beneficial and negative results. Therefore, spreading the lessons throughout the company and lowering the risk of repeating bad practices in future projects
- Facility Management Involvement: as the company has a client stance on projects, it can create a connection with the last players, such as Facility Managers, which gather information regarding building performance and maintenance measures. This informational loop allows for better design and requirements for other projects, thus optimising gains and standardising good practices.
- Standardise Reuse of Processes: the creation of a good practice and explaining how repetitive process should be completed will allow the company to optimise its time spent on projects and minimise response times within the frames of known processes. It also allows the possibility of newcomers to lower their integration time in the company.
- Model for Right Time to Involve Actors: as the company has a wide range of portfolios and an overall understanding of what the project entails, it can also use these capabilities, to create a model for when different actors should be included in projects. This creates a better communication line within the project as well as minimising the work time on each project for it will explain when other actors should be integrated and what they should offer at a certain time. This, in turn, sharpens communication efficiency as well as contracts.

These suggestions will aid the company in optimising time and resources which the company already has, therefore creating a more efficient and collaborative projects. These suggestions are also low cost, and will create more abilities for the company to instil circular processes that may come into the industry.

In order to improve the circularity of a company there are many different aspects which can be looked at. The focus of this thesis is, as mentioned, the processes which can be implemented by the companies in order to accelerate the circular transition. The solutions outlined and suggested for each of the companies are, therefore, focused on the feasible steps for each company, considering their size, focus, and motivation towards circularity. These are the solutions which are considered the most relevant for each company considering all this. This said, other measures will also aid the circularity of the companies. Therefore, the consideration and study of all the presented solutions is recommended, as they can aid the circularity and the performance of the company overall. The solutions are considered as a suggestion to the first steps for each company towards a more circular industry.

Chapter 8

Conclusion

There is an abundance of tools which have been developed with the aim of creating circular projects and companies. The more promising and acknowledged are listed in *subchapter* 7.1.3. But there is one main drawback with these implementation attempts, which is that they require the effort of the whole value chain in order to be successful at a larger scale. And as the first interview round suggests, one of the general problems in the Danish construction industry is that companies are not motivated to be more circular. This issue is currently beginning to be tackled by the current administration, which is taking new measures to improve this stance. The interviews also show that communication and collaboration are some of the weakest chain-links in this industry. Thus, adding to the distrust in the industry, creating a more complex and cut-throat competition approach for each company. In turn, this offsets the basic requirements for establishing a higher level of circularity. Consequently, this thesis offers more options for circular practices within the processes of each company, which yield better results than the current ones. These suggestions are outlined in subchapter 7.1.2 Communication, which are specified on for each company analysis. The development of these steps offers companies the possibility to implement these at their own pace and provide a way for the industry to improve through collective effort reaching a higher level of circularity overall.

These communication solutions will aid the company's ability to collaborate within the industry thereby making it possible to implement the tools along the value chain. Which, in turn, will allow for the industry to reap the benefits of circular economy. Thus, allowing tools such as buildings as material banks to be implemented at a larger scale, which is feasible only if the whole value chain is working at the same wavelength towards the same goals.

Through the developed method companies can achieve the necessary understanding of their position within circularity practices, regarding internal processes, is provided. When the specific analysis, comparison and suggestion, are completed, it is possible to outline the main issues and offer a new range of opportunities, which, in turn, make contributions to the circularity of each individual company. Furthermore, the method offers the possibility for any company to apply a similar process to analyse their own structure and, thereby, obtain an understanding of how they are excelling in circularity, and which pillars they can benefit from improving. Based on these pillars, they can use the related solutions from the established communication categories, and through this, choose the relevant processes and implement these in whichever manner suits the company's values and business model.

Due to the fact that total circularity is currently not possible, the authors can not claim that this was achieved. But, it can be stated that on account of the analysis and suggestions made, the possibility to achieve a higher level of circularity is increased. For if only one of these companies implements one suggestion and becomes more circular, the industry as a whole will benefit. This, in turn, fulfills the study's aim of bridging the gap towards a higher level of circularity.

8.0.1 Further Research

This subchapter outlines the areas in which further investigation and research would benefit the aim of the project, but, which for various reasons, were outside of the scope of the project.

One of the main issues established through the interviews, apart from those connected to the communication in the industry, is, as mentioned, the need for governmental pressure. During the interviews most companies have stated that without this kind incentive from the public, the implementation of circular economy at a larger scale cannot be achieved. As for this claim, it is also important to understand that creating laws and regulations, would require the creation of an infrastructure which aids these changes and new practices. The issues retained to the government, municipality and other public entities, thereby the market and the laws, are outside the scope of this project, as the companies and the industry itself cannot present solutions to overcome these. Therefore, it is recommended that the potential for governmental influence on the circularity of the industry is investigated further. In the investigation, it should be considered what measures can be taken, how efficient the proposed solutions would be and the cost versus benefit of the implementation of circularity frames and pressures. At the same time it is important to consider how to maintain equal opportunity for the companies in the industry to compete within the new outlines. This area is considered the most relevant for furthering the implementation of circular economy in the Danish construction industry.

Due to the trend that is uncovering itself at this time, it is imperative to develop further studies in this area, in order to establish a new normal.

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Appendix A

Chapter 5 Appendixes

A.1 Full List of Questions Interview Round 1

1. What do you (as a company) do? (Which roles in the construction process do you handle)

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250

1.2. What is your personal area of expertise?

2. What is the core of your company's expertise? Does that differentiate you?

3. When offered new projects how do you decide on which projects you will accept?

4. What values are your usual customer segments asking for?

4.1. How do you connect with clients and what is the interaction like?

4.2. How is the client involved in your processes?

4.3. Do you have any influence on client decisions? - How?

5. What determines who you collaborate with? (Subcontractors, suppliers)

5.1. How do you think the collaboration between the different players in the industry is?

5.2. What would you improve?

6. After you finish and deliver a project, are you involved in further processes?

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

8. Are you familiar with the term Circular Economy?

Y: What does it mean to you as a company?

Y: Are circular economy and sustainability the same?

A.2 Hypothesis Development

#	Statement	Quote	Source
A	Private companies can benefit from circular economy and they can help push the system.	"Good policy offers short- and long-term economic, social, and environmental benefits. But success in increasing our overall resilience ultimately depends on the private sector's ability to adopt and profitably develop the relevant new business models." "Our case studies demonstrate that the principles of the circular economy—if thoughtfully applied—can provide short-term cost benefits today and some striking longer-term strategic opportunities as well as new profit pools in reverse cycle services"	Towards the Circular Economy: Economic Business Rationale for and Accelerated Transition - Ellen Macarthur Foundation 2013

#	Statement	Quote	Source
		"Instead, we have selected a broad range of manufactured products to illustrate the various design choices and business model changes that may help companies reap the benefits of a more circular product and service portfolio. For some complex products, we go into more detail, because it is here where the case is most difficult to make. The sector focus of these analyses is on manufacturing and, here, the final production stage of the value chain. In other words, we do not analyse the economic effects on uostream participants in the market."	Towards the Circular Economy: Economic Business Rationale for and Accelerated Transition - Ellen Macarthur Foundation 2013
В	There are no "one size fits all" solutions in circular economy	"In the new concept of CE, recovery and valorization of waste allow reusing materials back into the supply chain, finally decoupling the economic growth from environmental losses"	Measuring circular economy strategies through index methods: A critical analysis - Valerio Elia, Maria Grazia Gnoni, Fabiana Tornese. 2016
		"The specific process of tracking material and energy flows in industrial systems is usually called industrial metabolism, while inter company relations and constellations that aim to optimize resource use by exchanging by-products, reusing waste products, producing energy from waste and sharing utility are called eco-industrial parks, industrial symbioses or industrial ecosystems."	Breaking the stalemate of sustainable consumption with industrial ecology and a circular economy - Oksana Mont, Eva Heiskanen

#	Statement	Quote	Source
		"The research findings have shown that this is similar for applying circular economy principles with the respondents stating that a lack of holistic approach and the 'silo' approach of undertaking design, construction, facility management and end-of-life activities are the key challenges."	Circular Economy in Construction: current awreness, callenges and enablers Katherine Tebbatt Adams, Mohamed Osmani, Tony Thorpe, Jane Thornback. 2019
с	Companies in the construction sector have a linear approach	"In view of these challenges, many stakeholders regard the CE concept as an important step to create more financial, social and environmental value by taking a systemic view on the whole life cycle of buildings and by using new technologies and design approaches. This enables to move away from a 'take-make-dispose' paradigm to a circular perspective on material reuse."	Circular Economy in the building sector: Three cases and a collaboration tool - Eline Leising, Jaco Quist, Nancy Bocken.2017
		"Buildings are unique entities, as they are often the results of one-off projects. This feature adds to their inherent complexity, where each of the materials used has its own specific life cycle and all interact dynamically in space and time. Furthermore, their long lifespan, and changes of use during their service life, lead to increased uncertainty about future scenarios."	Circular economy for the built environment: a research framework - Francesco Pomponi, Alice Moncaster -

#	Statement	Quote	Source
		"The research findings have shown that this is similar for applying circular economy principles with the respondents stating that a lack of holistic approach and the 'silo' approach of undertaking design, construction, facility management and end-of-life activities are the key challenges."	Circular Economy in Construction: current awreness, callenges and enablers Katherine Tebbatt Adams, Mohamed Osmani, Tony Thorpe, Jane Thornback. 2019
D	There are a lot of individualistic company processes (only thinking about themselves)	The focus on circular buildings is particularly relevant for supply chain collaboration circular buildings is particularly relevant for supply chain collaboration because a building is a complex "object" with several layers, such as the facade, the service equipment and the structure (Brand, 1994) each having their own time frame for operation (Pomponi1994) each having their own time frame for operation (Pomponiand Moncaster, 2017). These different time frames are linked tomany parties along a building's supply chain making the closure ofmaterial loops along the total lifecycle of a built object highly challenging.	Circular Economy in the building sector: Three cases and a collaboration tool - Eline Leising, Jaco Quist, Nancy Bocken.2017

A.2. Hypothesis Development

#	Statement	Quote	Source
		"Other barriers include the lack of a holistic approach across the supply chain, short-term thinking and the low value of many construction products at the end of life"	Circular Economy in Construction: current awreness, callenges and enablers Katherine Tebbatt Adams, Mohamed Osmani, Tony Thorpe, Jane Thornback. 2019
E	Companies are sometimes short- sighted, and only look for profit	"Developers construct, redevelop or refurbish buildings. They consider a building as a short term asset. The goal is making a profit. They hire third parties to execute design, construction, maintenance and demolition."	Scaling the Built Circular Environment: Pathways for Businesses and Govenment - World Business Council for Sustainable Development. 2018
		"Each individual company strives for gaining economic benefits in order to secure profitability and a competitive edge."	Towards circular economy implementation: a comprehensive review in context of manufacturing industry - Michael Lieder, Amir Rashid. 2015

#	Statement	Quote	Source
F	Larger companies have a more long- term approach so they spend resources to plan accordingly to stay relevant (innovation)	"Many larger companies are increasingly adhering to circular principles in the sectors of finance, technology, resource management, client relations and ownership structures. Smaller companies (Small and Medium sized Enterprises or SMEs) and start-ups are more progressive in their business model reforms, more agile in applying new disruptive technologies and market approaches. However they do not have access to large markets and finance as multinational companies do."	Scaling the Built Circular Environment: Pathways for Businesses and Govenment - World Business Council for Sustainable Development. 2018

A.3 Development of Questions for Interview Round 1

The research and aim of the developed questions are outlined in the tables below.

#	Statement	Reflection	#	Question
	Private companies can benefit from circular economy and they can help push the system.	State if the company is private, and where are they involved in the chain	1	What do you (as a company) do? (Which roles in the construction process do you handle)
		Establish size of the company, how much influence and impact does it have in the industry	1.1	How many people are employed in your company?
А		Information about the interviewees knowledge, interest and influence in the company	1.2	What is your personal area of expertise?
		Market influence definition	5	What determines who you collaborate with?
		Company's influence in its chain	6	After you finish and deliver a project, are you involved in further processes?
		Company's interest in the topic	7	Are you familiar with the term Sustainability? (what does it mean to you as a company?) Are you familiar with the term
			8	Circular Economy?

#	Statement	Reflection	#	Question
		State company's business and interest	1	What do you (as a company) do? (Which roles in the construction process do you handle)
В	There are no "one size fits all" solutions in circular economy	Categorization of type of company, size might be a similarity among companies	1.1	How many people are employed in your company?
		Categorization of interviewee, different jobs have different viewpoints	1.2	What is your personal area of expertise?
		Categorization of type of company, area might be a similarity among companies Categorization,customer' s need might be a	2	What is the core of your company's expertise? Does that differentiate you? What values are your usual
		similarity among companies	-	customer segments asking for?

#	Statement	Reflection	#	Question
		Categorize business style, define interests	2	What is the core of your company's expertise? Does that differentiate you?
		Define selection criteria and interests	3	When offered new projects how do you decide on which projects you will accept?
		Define customer segment and tendencies	4	What values are your usual customer segments asking for?
		Define selection criteria and interests	5	What determines who you collaborate with?
C	Companies in the construction sector have a linear approach	Opinion, find pains to target on processes	5.1	How do you think the collaboration between the different players in the industry is?
		Define if collaboration in the company is common. State long-term VS short- term	6	After you finish and deliver a project, are you involved in further processes?
		Company's interest in the topic	7	Are you familiar with the term Sustainability? (what does it mean to you as a company?)
			8	Are you familiar with the term Circular Economy?

#	Statement	Reflection	#	Question
		State how open is the company to collaboration	2	What is the core of your company's expertise? Does that differentiate you?
	There are a lot of individualistic company processes (only thinking about themselves)	Does the company have a tendency due to a specific (personal) process?	3	When offered new projects how do you decide on which projects you will accept?
D		Does the company work with a usual cluster of collaborators	5	What determines who you collaborate with?
		How far do they extend their unique services	6	After you finish and deliver a project, are you involved in further processes?
		Company's interest in the	7	Are you familiar with the term Sustainability? (what does it mean to you as a company?)
		cooperate or collaborate	8	Are you familiar with the term Circular Economy?

#	Statement	Reflection	#	Question		
		State type of projects, and if they look for longer term projects	3	When offered new projects how do you decide on which projects you will accept?		
E		Short-term sighted client segment, proposes just that	4	What values are your usual customer segments asking for?		
		State if company is open to future works with same players	5	What determines who you collaborate with?		
	Companies are sometimes short- sighted, and only look for profit	Do they picture the industry as a whole? Systems thinking	5.1	How do you think the collaboration between the different players in the industry is?		
		Willingness to change Business Model, if there is a big enough market and capabilities	6	After you finish and deliver a project, are you involved in further processes?		
		Company's interest in the topic, long term is easier to make sustainable and circular		Are you familiar with the term Sustainability? (what does it mean to you as a company?)		
				Are you familiar with the term Circular Economy?		

#	Statement Reflection		#	Question
		State size of company and span of portfolio	1	What do you (as a company) do? (Which roles in the construction process do you handle)
F	Larger companies have a more long-	Categorize size of company	1.1	How many people are employed in your company?
	term approach so they spend resources to plan accordingly to stay	Do they have a variety of customer segments or just one, innovation varies in each Long-term thinking has to	4	What values are your usual customer segments asking for?
	relevant (innovation)		5	What determines who you collaborate with?
		decisions	6	project, are you involved in further processes?

The process of developing and the aim of each of the questions for the first round of interviews, will be outlined in the following section.

Question 1

The aim of the first section of questions is to establish the company and interviewee, in order to understand the biases, approach and position in the value chain. This understanding allows the authors to maintain intent and context, which lowers the possibility of deviating the interview answers and data, with which the company is located and views the industry. The question aims to confirm if the company is public or private, state the company's business and interests; and state the size and possibly the span of their portfolio , in order to assess it.

Question 1.1

This sub question of the first part, confirms the categorisation of companies as either small, medium or large enterprises, according to Danish law. This will allow to understand the amount of influence a company has on the value chain and if there are any similarities among companies in the same size range.

Question 1.2

This aims to establish an understanding of the point of view of the interviewee, for it may change according to where they are located in the organisational structure.

Question 2

This aids the categorisation of companies into specialties and stances in the value chain, it allows the authors to understand how they affect and are affected by the industry. This also allows the understanding of their interests, and their willingness to collaborate with others.

Question 3

This question offers and understanding of the company's selection criteria as well as interests in the industry, and state if there are any specific unique practices within it. It also opens the possibility for the interviewee to state if they are interested in long term projects.

Question 4

This question aims to shed some light on the company's market and customer base, what they are looking for and what motivates them to contact and work with this company. It also offers the chance to confirm if the company's strengths are what they are sought for.

Question 4.1

This subquestion, opens the interview into the discussion of how clients and company's work, and their stance in collaboration. But, also to understand how they acquire customers.

Question 4.2

The second subquestion aims to understand the opportunity the company has to influence the client, and how far can this influence reach.

Question 4.3

The third subquestion aims to widen the understanding how much influence companies have on the client, how much do they realise that they have.

Question 5

This main question is used to state the market influence definition of each company, define their selection of collaborators and partners, which in turn shows their interests, and how open they are to new collaborators.

Question 5.1

This subquestion is aimed to give a better understanding of how much a company collaborates with others, and their experiences in these collaborations. Company pains can be found in this question, and how the look at the industry, as a whole or as separate players.

Question 5.2

This subquestion is a follow-up of the previous one, where after explaining their pains, the interviewee has the opportunity to discuss what they would like to modify or improve in the industry. This question also allows the author's to focus on specific

Question 6

This part enables the interviewee to explain further processes, and how their projects are looked at (short or long term), and the company's willingness/consideration of modifying their business model on the long term.

Question 7

The last two questions are for the author's to have a better understanding of the company's views on the general subject of the thesis. This question refers to sustainability and how is it understood by the company, and how much investigation has gone into the posed opportunities by the concept.

Question 8

This question refers to circular economy and how is it understood by the company, and how much investigation has gone into the posed opportunities by the concept.

A.4 Interview Compilation

· · · · · ·	1		1						
Туре	Company	Interviewee	Interviewee Role	Q.1 What do you do as a Company	Q.2 Cos area of expertise /edge	Q,3 How do you select projects	Q.4 Values asked by customer segment	Q.4.1 How is the interaction with clients	Q.4.2 Involvement of client
Architect	Lendager	Magnus Kuhn	Project Manager	architecture and on-site advisors	Sustainability and design	Sustainability focus	Sustainability and usability	competitions, now customers look for them. This offers more influence	Client's choice, open to involve them completely
Architect	LINK	Torben Heldbo	Project Manager	architecture, on site advisors and FM	Tailored design/company size and portfolio	Realizability. Possess adequate resources and experience	Specialized knowledge	competitions, experience 30% of work is by clients approaching	Client's choice, open to involve them completely. As soon as permits come in, its about money
Contractor	Dansk BoligByg	Kris Houmann	Department Manager	Pure management contractor. Main contractor, turnkey contracts. Work with mainly public	Good collabs and partnerships for good pricing.	Depending on the collaborating companies	good pricing, easy process for clients, hearing the customer, delivering what is agreed upon	Competitions	Client's choice. Bureaucracy is an issue with bigger clients
Contractor	Enemærke og Petersen	Peder Johansen	Director of customers and management	Renovation on public or half public. New construction for private. Strategic partnerships	Collaboration culture and strategic partnerships. Value creation, process development and continuous improvement	Core competences of the company. And size and possibilities of a project	Secure processes and value creation	Dialogue and conversations	Dependent of the project type. In trade contracts there is little collab, in turnkey lits better. Involve customers as earlyas possible (plot procurement)
Client	S. Enggaard	Karsten Westergaard	Project Manager	Developer (private client)	Not a lot. Bagaining powerr because we can make our decisions ourselves. Money is not an issue, neither is working with others	Location of the development. Infrastructure neded for buyers	How profit can be created for customer	Inquirees from possible customers, or just talk to their networks about a new product they will have	Sometimes involved. Mainly to push the profit they will make from the project
Contractor, Manufacturer	ScandiByg	Mads Simonsen	Development Manager	Turnkey and module supply.	Industrialized approach that enables optimization and productivity. They are "Svanemærket" branded	They select due to modular construction capabilities they have.	Sustainability, quality. Competitive pricing, delivery and customer satisfaction	Networking, good relations and winning tenders	From the beginning of processes, on turnkey. They need to settle questions before production starts
Engineering	NIRAS	Claus Topp	Head of construction dept	Client consulting, design and in some cases construction management	Expertise, portfolio and collaboration/tea mwork	Competitions, recurring customers. It either needs to have good margins or learning opportunities, both would be best	Good collaborations and simplification of work. Prioritization of loyal clients	Competition and recurring customers	Very involved, the fixed price is an issue for the customer can only suggest within that
Engineering, Contractor	MT Højgaard	John Sommer	Director of strategy and business development	Turnkey contractor, PPP contracts (up to 25 years), mostly public contracts	Portfolio and expertise	Meeting the requirements and resources needed. Profitable and staying in their area of expertise	Expertise and experience	Tendering, or returning customers. They can choose to be involved	Depending on the type of contract AB or ABT, they have tried to do a mix where the customer is more involved and gets the best of both worlds
Client	Alabu	Brian Hansen	Project Manager	Public housing association	Social sustainable connections to their clients, with the democratic organizational boards, development of sustainable housing and possible certifications	Limited by public frameworks, hinders them in building sustainable buildings considering the ease of maintenance	Connection and collaboration with clients, organization board and department board	The clients are part of the board, so they have decision and collaboration power	The clients own the houses tehmselves, so the company works as an administration for them, the residents are part of the board

A.4. Interview Compilation

Q.4.3 Influence in client	Q.5 How do you chose who you work with?	Q.5.1 Is the collaboration in the industry good?	Q.5.2 What would you improve on 5.1	Q.6 are you involved after delivery?	Q.7 Are you familiar with sustainability?	Q.8 Are you familiar with Cirec
Yes, they also use advisors to get more influence	previous positve dialogue. Turnkey restrictions.	2/10, people want to deal only with 1 person. Contractor's focus is only money	Client stance, stronger clients		Yes. Reduce number of resources, and more efficiency (they insinuated this)	Yes. DNA of company
Good, until drawings are completed, then the client disconnects	Public tender rules	It is getting better, to make sure that the product is what was asked for. Interested in meeting sustainability demands		Facility management as a contract from Q1	Yes. Combination of Environmental impacts, indoor climate, usability, etc	Yes. Focus on reusability of materials. Also the ability to design for change
Yes, they can make a lot of decisions on behalf of the client.	Competition based, good relations	Late entry due to how processes work, makes it difficult. Public entities are slow. Maximum profit based, and this needs to change for the industry to change.	No answer, the amount of money spent on processes is a problem. The municipality has to lead change	Nothing beyond guarantees	No concrete position	Yes. But they dont use it, they recycle what they can if it offers financial gains
When involved early, the influence is substantial. They try to push sustainbility	Mostly price, competences, relations, willingness to collaborate.	Could be better, bureaucracy gets in the way and the value chain, which creates distrust. The industry is behind. It is getting better at collaboration and integration	Collaborations and strategic collaborations should get pushed more. This can be done by the government	FM, but it is rare	Yes. Traditional social, resource and environmental. It has been strengthened by the SDGs	Yes. They studied it for 2 years and placement on the value chain. Upcycling, and business model side. The started a circular resource plan.
Partial influence, only within tight margin of the project	Usual turnkey contractors. They use regular collaboration partners	Private customers, dealing with turnkey contractors this minimizes problems with the collaboration	The communication in the industry. The agreements are too vague, this leaves a lot of space for conflicts	Usually they manage the buildings they built. This puts an emphasis on quality and performance	Connected to the NBE. Sustainability is an old process but the name and focus is new. Pressure must come from the client	Knows it vaguely, they are not involved or apply the concept
on tender not much other tan prices. When it is brought by network then it is different and they get to use the sustainability approach and get ideas through.	work mostly with the usual architects who know the module limits. The list is expanding	Hard scene between contractors and for contractors. Based on relations, and the more you have the more likely it is to have a bad one	The tender process works limits collab. It is price driven and this is a problem. When the customer comes in by themselves there is more leverage which is expensive at first but pays off on the long run.	No	Yes. sustainbility is also economical and social. The focus has been on green.	Yes. The company has been circular by default (they achieved it without striving for it). The produce a product that maintains value after disassembly.
Yes, advise from consultation and offering alternatives to customers	previous relationships and good past experiences	Its OK. Open tenders have more issues than private	Price driven industry, this creates tension and narrows the view on projects due to closed constraints	Sometimes they deliver a project and do construction management. Usually they dont	Yes, trying to follow SDGs, focus on quality and easy maintenance	No, unless the customer asks for DGNB certification, in such case design for disassembly and recycling is investigated.
If given the chance they will advise, if concerns are being held they will make sure the customer knows and try to resolve the issue	By competences, prices or repuation. It depends on the type of activity, several approaches might be taken	It works OK. You work with people not companies, so it mostly depends on the person you are dealing with. If every party wants to optimize a project, it will run fine, if one party aims to defend their position, it will be harder	Communication, inter phases are too costly at the moment	Looking into maintenance in some areas. Usually just involved in their PPP projects	Very involved with the Danish green council. One of the companies best suited to do sustainable construction in DK.	Part of the group, along with 50 companies, that designed and built the circular building
Yes, we advice clients about construction materials and constructions	Public tender rules	It works pretty well. Profit is an issue between client and contractor. Usually we try to avoid turnkey, they offer less control. Main contracts this ensures that they deal with one point of conflicts of interest.	More prcision in the development of contracts, be critical of the material suggestion. Clients have to be sharp		Yes, they are part of the NBE, it is very important to them. They want to lead in sustainability in Northern Jutland. They are focused on DGNB in the construction. They could be part of the re-use cycle because of their responsibilities to deliver to the client	Yes, it is the way to go. Although the time frame is long, but it is starting the process of change. Processes have to be inspected

A.5 Lendager Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

Architect (normal), work in all the phases as prelim. Design sketches, main design and on-site advisor

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 Arc: 25, Lendager: >50

1.2. What is your personal area of expertise?

Building technics and project management (and circular thinking)

2. What is the core of your company's expertise? Does that differentiate you?

Sustainability and design. Must be a part of every project -> no regular projects. The projects must include sustainability in some way. This is what differentiates them.

3. When offered new projects how do you decide on which projects you will accept?

Any project which is sustainable.

4. What values are your usual customer segments asking for?

The values that the clients are usually looking for in Lendager are usually from the sustainability standpoint. Aside from sustainability, even if not asked for, Lendager focuses on the usability for the client.

Depends on the client. The company is known to be sustainable, so this is why people reach out. Sometimes for 'green washing' and sometimes due to genuine interest.

Clients with no actual interest makes the company push and 'fight' for actual sustainability.

One value is the other parts of the company (TCW and UP)

4.1. How do you connect with clients and what is the interaction like?

It has changed this year. Usually they put out offers and went into competition. This year clients have been coming in. This is beneficial, because if the client contacts you, you have more influence and leverage. They can't really tell if it is a trend but hopes that it is because of their focus and becomes a bigger part of the industry. (He met with the building minister from CPH, they are working to put requirements in the new construction documents that require builders to use 20% recycled materials, it is always positive to see some initiative from officials).

4.2. How is the client involved in your processes?

It depends, it relies mostly in the client. Some clients are interested in sustainability and practices and want to be involved. Some just want to build and deal with the least amount of people possible (currently working on a project where they are doing an early stage workshop with the client (diagramming and choosing materials, they try to push reusing, recycling, an renewables, which they suggest at the workshops).

Many clients want to be involved in the process

Usually working with total contractors and it seems that that is where the industry is heading.

For the most part turnkey contractors just want to do it the easiest way this means that it is very difficult right now to convince contractors and engineers. (He was distancing himself from the E and C, and making it clear by word and tone that he thinks they do not care enough about creating something sustainable/circular/innovative)

4.3. Do you have any influence on client decisions? - How?

Yes, sometimes they even get a chance to bring in consultants to deal with processes that they want to implement, such consultants pitch to the clients in a more accessible manner.

In workshops and else, they use the TCW department members to connect with customers

5. What determines who you collaborate with? (Subcontractors, suppliers)

Mostly based on positive previous dialog (engineers) (if they get to choose, not always). Contractors usually can't be chosen, due to the nature of the contract (turnkey). (concrete case, they use concrete because they already had bought the slots. It is hard to sway somebody in this scenario where the situation is already fixed, in this situation it would be better to look at other parameters, such as social, and make those more sustainable).

Some contractors are more willing to consider sustainability than others, can make a big difference in the collaboration.

Sometimes limited because total contractor is in charge of the building system early in the process.

5.1. How do you think the collaboration between the different players in the industry is?

2/10. Customers usually go for turnkey contracts to deal only with 1 person, they end up with same price, lesser quality (no opinion input), but with less attention on the project.

Sometimes better in turnkey contractors because better communication during the process, thinking about how the contractor can do it. Rather than only getting contractor input after tender. Contractor's focus is always money. Client and local plan must push.

5.2. What would you improve?

Client stance, a strong client can hold the sustainability of the project by making a stance. Private developers go for the market needs (mostly), that means cheap prices (sometimes even just greenwashing). Easier to work with public clients.

6. After you finish and deliver a project, are you involved in further processes?

Y: How are you involved?

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Means a lot of different things within the company.

Their aim is to reduce the number of resources put into new projects (materials). Creating projects to showcase, and also playing some kind of influencer part but they are restrained by technology or costs, not necessarily at the same time. They make show projects.

8. Are you familiar with the term Circular Economy?

Circular economy is in our DNA, pushing the agenda through all their branches, specially through TCW, where they guide others in other industries (eg Carlsberg project), and education of clients.

Sometimes pushing it without saying 'circular' and 'recycle' to the client.

Y: What does it mean to you as a company?

Y: Are circular economy and sustainability the same?

Make less of an impact on the environment, cafeteria diet, biking to work, meeting decisions (flights), clothing options, etc.

A.6 LINK Arkitektur Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

Architectual company, does architectural advisory and supervision throughout design and sometimes construction process. Also covers facility management at times, not always, usually covers a period of 15-20 years.

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 More than 250 overall, in Denmark about 90.

1.2. What is your personal area of expertise?

Design manager (Projekteringsleder). Is involved in all the stages of a project, from the initial suggestion and sketching (client contact) to construction or tender of the project. Handles a lot of interdisciplinary coordination between architects, engineers etc.

2. What is the core of your company's expertise? Does that differentiate you?

The size of the company differentiates, it means that in house there are a lot of people employed with specialisations, which makes it easy to get qualified people on the different projects.

Especially expertise in hospitals as the previous Aarhus arkitekterne, which has +30 years of experience in the area.

A lot of social housing projects as well. Both renovation and new construction.

Ca 30% of projects are clients approaching, the rest are won in competition. Winning competition on the basis of the right descriptors and drawings, but maybe more importantly being able to connect the right resources (attaching the right CV's) to the project.

3. When offered new projects how do you decide on which projects you will accept?

The realisability of the project is a determining factor.

Considerations in regards to the availability of resources, are the correct CV's going to be available at the time. Ensuring that there is flow in the different segments in the company.

Also who is the client, there are very different ways of being clients and some are preferable to others.

Ultimately, however, it is a business, so when there is availability in the resources, they will try and fill this with whichever projects are available, to keep the wheels running so to speak.

4. What values are your usual customer segments asking for?

The broad spectrum of specialised knowledge.

4.1. How do you connect with clients and what is the interaction like?

They are a part of the project all the time, some want to have a lot of influence some don't, but many of their projects are user related, which means that they work with user meetings and work with the users in order to determine and optimise the use of the building. Once the building permit has been gained the user influence is less as it is focused on price etc.

4.2. How is the client involved in your processes?

Within the frame of the project, the money, the architecture, that aesthetic it's a collaboration to reach the best use of the building. The experience of the company is driving the decisions (the clients trust in the architects' knowledge and experience of what creates a better building (better flow, use space etc.)) Once all decisions are made the users are disconnected from the project and then the drawing is finished by the architects.

4.3. Do you have any influence on client decisions? - How?

Within the frame of the project, the money, the architecture, that aesthetic it's a collaboration to reach the best use of the building. The experience of the company is driving the decisions (the clients trust in the architects' knowledge and experience of what creates a better building (better flow, use space etc.)) Once all decisions are made the users are disconnected from the project and then the drawing is finished by the architects.

5. What determines who you collaborate with? (Subcontractors, suppliers)

Because they do many public projects, these have to adhere to the public tender rules. When they are designing the main project and tendering it to the contractors in tenders after DD2, then there is a collaboration with the producers. The big producers have consultants who drive out and who the architects have contacts with so that they can talk together and collaborate to ensure that the elements which are drawn in the project are actually constructable and deliverable. To this comes that they also have to ensure that more than one company can deliver the requested in order to maintain the competitiveness on the products and not drive up the price.

There is also considerations in regards to weather it needs to be certified. (Sustainability, DGNB etc.) Which documentation needs to be present, how do we ensure it? Etc. The material choices etc are very important in this aspect.

5.1. How do you think the collaboration between the different players in the

industry is?

They think that there is an increased interest in aiding in ensuring that the finished product lives up to the demands and goals made early.

All are more focused on helping the project meet the sustainability demands etc. The producers are focused because there is an increased market. Its good business

5.2. What would you improve?

6. After you finish and deliver a project, are you involved in further processes?

Y: How are you involved?

Facility management, see question 1. Sometimes, but not always.

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Sustainability is many different aspects. Environmental impacts, indoor climate, usability etc.

The combination of all of these things being considered

8. Are you familiar with the term Circular Economy?

Y: What does it mean to you as a company?

Focus on the reusability of materials.

And also the ability of designing prepared for the change of use in a building.

Y: Are circular economy and sustainability the same?

They are very connected, but you cannot put an equal sign between the two. Circularity is about understanding the reuse and recyclability of the building and materials. The sustainability expands beyond the lifecycle consideration.

Do you think circular economy is useful and feasible?

100% achievement is probably too ambitious, but we are on the way. The development of production methods, techniques and technologies is creating ways it can be done, so it should be possible in the future. And the continuous development creates a positive outlook.

Reconstructions and renovations on public buildings (hospitals and schools) happen all the time. Because of developed needs, flows etc. When doing these renovations, they are trying to plan come constructions where these types of renovations are financially tolerable and where the buildings more easily can be reconstructed. Preparations for the indoor climate and installation of the building, so that these can handle the renovation / reconstruction. Designing the first with some over capacity will allow for savings later and ensure easier changes and less waste of resources during these changes. (The trick is to have the understanding of when reconstructions are likely to happen and thereby prepare these exact buildings for it, so that buildings are not designed with overcapacity frequently which is not utilised.) Ensuring that the building is prepared for any changes.

Report for Technologisk Institut: Cirkulær økonomi sætter dagsordenen i fremtidens byggeri.

A.7 NIRAS Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

Niras is a big company, in the building industry we do both client consulting (where we advise the client to help get him what he needs) and design (brief design) always in collaboration with architects, all the calculations.

And then we also do construction management in some cases (different departments). Our biggest challenge so far is the university hospital in Aalborg, that is our biggest construction management job at the time. (It is like another branch of the company)

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 2000 – 8000 in building related jobs

1.2. What is your personal area of expertise?

I'm Head of the department in north Denmark (Aalborg). Expertise field is within indoor climate energy consumption and sustainability.

2. What is the core of your company's expertise? Does that differentiate you?

I used to tell our clients that we offer the full service, we can do all the disciplines that they need, and we are also good at working together. We have colleagues that we can pull into projects to help us, so the client does not need to shop more than once. We think we are good at this, and according to customers it is.

A broad knowledge spectrum, and ability to pull in specific expertise from within and outside of the company. Collaboration is easier because they assign the same teams to the same clients which enable a better team chemistry.

3. When offered new projects how do you decide on which projects you will accept?

When we get new jobs it's a mix of winning competitions, or re-sales to existing customers. But we always look at the job, it needs to be interesting. It needs to have the potential for us to learn or to make money. Both would be great. If we don't learn and develop from a project, we are not able to keep or attract our work. Mostly we prioritise our most loyal customers.

Profit and learning experiences (new types of projects to develop the company into new tendencies)

4. What values are your usual customer segments asking for?

It's often based on good experience from previous projects, they usually ask us to bring the same team to work with them, I think they did a good job so they like this. We tend to keep the same people in the office and in groups. The same company also usually brings the same team, so they know how to work together. Collaboration is easier because they assign the same teams to the same clients which enable better team chemistry. We prioritise their repeating clients (clients they've had before).

4.1. How do you connect with clients and what is the interaction like?

Competition (tendering) and recurring customers.

4.2. How is the client involved in your processes?

Very interested and they can be involved as much as they want, but most projects are on a fixed price, they have a limit on how much time they can spend with the customer. Changes to the project might require money. "Money is always an issue"

4.3. Do you have any influence on client decisions? - How?

Yes, we have to advise, some lean on what we advise. Others we suggest what we can do, and then they decide, some ask what we suggest, others ask what happens is we take an option or another. We don't just do what they ask, we see if there is a better choice and we tell them about those options. Money is always an issue. They usually build it and sell it, they sometimes don't care what are the running costs, they just want a building that is not too expensive.

We consult with them and propose all the solutions that we can offer, also suggest the one we think best (if asked for opinion).

5. What determines who you collaborate with? (Subcontractors, suppliers)

We have a number of jobs which are total contracts. We go with the total contractor most often, then we team-up. We have good relations with some. If it is subcontractors we make our material, and if its an open tender we have no influence, if it's an invited tender, we ask the client if they have a preference of who we should ask. We have had some good relations with the contraction process.

Previous relationships, and suggestions based on good experiences. There are more conflicts when there is an open tender.

5.1. How do you think the collaboration between the different players in the industry is?

It's OK. We have experiences of good and bad. There's also the issue when a client asks which contractor they should ask, our suggestion is based on where we have had good experiences. In general, most of them are good.

We also experience some time that it's not always like a team, it sometimes seems like we are opponents, they wanted the tender, they won it under some assumptions, and sometimes they are overly optimistic. So when things start going the
wrong way they start fighting and it is not as efficient.

Open tenders have more issues than closed or invited ones.

Price driven industry makes it hard to work in and create innovation, a small mistake can cut your profit margin.

5.2. What would you improve?

I think one issue where we have had bad experiences before, is that the building industry is under pressure, due to price. Money is very important, as a consultant, we don't make a lot of profit 4-7% a year, it's a marginal business. We think it is the same for the PM. There is not a lot of space to be more relaxed about it, this forces the different actors into being very narrow-minded of their own business. There is not so much motivation or willingness to develop the process. It is always easier to say give me more money and I would make it better. The process is important, whether the design process or others. We understand there is a lot to work on, and then design and planning is where you start.

Pressure on money in the industry, forces the stakeholders makes them narrow their view within their business. The process is most important, with an emphasis on the beginning and planning.

6. After you finish and deliver a project, are you involved in further processes?

When we have delivered then comes the construction part, in some projects we also have the construction management part. In some we are done when we deliver, we also have some projects where we have a supervision agreement, we have to do some visits and we do that and supervise. That can be from 0 to very involved. We like to be involved, it is a bit poor just to do only calculations and just be done, our colleagues like to see the fruit of their work, where they see the project, it delivers satisfaction.

No, we deliver what we were contracted for, that could include construction management, but other than that no.

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Well, first of all, we are starting to find our way through the UN sustainable goals (SDGs) we are trying to make our colleagues aware, and explain how we actually do our projects, that is a long difficult course. But sustainability is a lot of things, but we also know that if we don't bring the right quality in, if we have the wrong architects we will have an engineering building that will be efficient but won't last, long term design is brought by architects. We look into maintenance and running of things that come afterwards, we do construction that requires little maintenance, that is the target we agreed to go with.

Yes. We are starting to find our way through the SDGs. Sustainability means a lot

of different things; we try to focus on creating projects that require maintenance. (look into this, personal comment)

8. Are you familiar with the term Circular Economy?

We don't really apply it because our customers are not so eager, or are not really asking for it. We do some things because our client wants it to be certified by DGNB so we look into disassembly and recycling, we do little of the circular economy, but we are not circular. It is not so easy to do.

We still have to actually reuse the building for it to be circular. Sustainability and circular economy are not the same.

Yes. We don't do it, mainly because clients don't ask for it.

Y: What does it mean to you as a company?

Y: Are circular economy and sustainability the same?

NO they are not.

A.8 Dansk Boligbyg Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

The company primarily works with turnkey projects. Sometimes main contracts. In the bigger category, meaning not for private customers, but for professional clients and mainly cases of 50 million and up. They are a pure management contactor, have no workers employed. These are hired from other companies as sub -.

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 Approximately 100 employees

1.2. What is your personal area of expertise?

Department leader. Works with new projects, starting them up and ensuring that stuff is coming in all the time and maintaining contact to clients. Additionally, he works as a backup to the project teams which are working on projects on the sites.

2. What is the core of your company's expertise? Does that differentiate you?

Everything in this industry is surrounding the economy. They have many good collaborations/partnerships with companies who know that they can provide low prices. The company takes care of these relations. 50-70% is won in competition. Here the expertise of the company is being sharp, providing good prices, and understanding and delivering what the client needs.

3. When offered new projects how do you decide on which projects you will accept?

Try to be relatively selective in which projects they want to work on, but sometimes this is difficult as they still want to maintain some of the relations, and may thereby take on projects for the sake of collaborating with another company. It depends on the market.

4. What values are your usual customer segments asking for?

Provides an easy process for the client. Ensures the good collaboration. Listening to the needs of the client and taking care of these. Having respect for the investments of the client.

Sticks to the time frames and promises made to the client.

But also ensuring to be cheap, that's the underlaying factor.

4.1. How do you connect with clients and what is the interaction like?

Mainly contact through competition.

4.2. How is the client involved in your processes?

Mostly have repeat clients, involves them as much as they want to be. The clients are very different in what level of involvement they want, as they are professional clients, they either know and trust the process or want to have hands in everything. Bureaucracy can make the interaction with bigger corporate clients very difficult, as no one wants to make the final decisions.

4.3. Do you have any influence on client decisions? - How?

Yes, sometimes they can basically make most of the decisions on behalf of the client. But they don't have specific materials or processes that they are consistently pushing.

Ultimately the economy is in focus.

"On principle are we completely indifferent to what we are building."

5. What determines who you collaborate with? (Subcontractors, suppliers)

It is based on competition, but within a smaller collection of sub-contractors. Usually they ask contractors who they have good relations and good experiences with. 80% of the contractors they work with are repeated collaborations. People they know are proper, reasonable and who respect agreements.

5.1. How do you think the collaboration between the different players in the industry is?

The more people are coupled on to the project, and the later any of these are added, the harder the communication is and the more difficult the process.

When working with the public entities, you have to have much patience. EVERY-THING is about the economy, nothing will work out if the economy is not taken prober care of, this is client budgets, municipality budgets etc. This is the main challenge in the industry. This is where we need to find a solution. If the money isn't connected, then nothing will change.

Many architects can draw nice houses, but when you put a budget on it, it starts becoming an issue.

The blame game is real

Many issues now with the way the municipalities are running things. They sell plots at the highest profit, then someone building has to make a profit, then the municipality has to approve the plans, they increase the quality demands and to provide a profit for the client he has to increase the rent. This is why the municipalities are not doing everything they can to push circular economy. If it is more expensive to construct, then the plots must be sold for less, creating less profit for the municipality.

5.2. What would you improve?

He cannot see anything which can improve the current situation. The amount of money spent during the processes are a problem.

Whenever someone has tried developing partnerships and collaborations on anything other than money is has been unsuccessful (gone terribly wrong) [hamrende galt], probably because the industry is too damaged and has a lack of morals. The municipality must start the change.

6. After you finish and deliver a project, are you involved in further processes? No, nothing beyond the guarantees.

They have a few OPP projects, but that's not many (3-4 total), and they hire a company who controls it completely.

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

They have no concrete position on the matter in the company, which may be the political position. They have no focus and will not present it to the client. It is currently connected with an increased economy; therefore, it has no real interest for them and their clients.

8. Are you familiar with the term Circular Economy?

Y: What does it mean to you as a company?

They are familiar with it, but do not have a lot to do with it. They do a little sometimes in regard to the demolition of buildings. Typically, this is because the companies who work with recycling materials contact them for access to the materials which are demolished.

They reuse a lot, because it is financially beneficial. They crush the concrete, because they can reuse it on site, and because it limits the transport of the demolished materials. Back to economy.

They don't meet people how want to pay for the recycling itself.

Y: Are circular economy and sustainability the same?

Yes. I would say it is.

Circular economy is more focused on resource use, and circular economy is sustainable.

Very critical of the processes behind recycling. Fx a building made with recycled bricks. First of all they are expensive, second, they were driven from one place, to where they were cleaned, cleaned, driven to storage, driven to a new plot. It this all in all sustainable?

"Not to sound pessimistic, but I think there is a very long way to go"

Crushing it etc. is the better solution right now, because it is possible and it is beneficial and we can all see that. Also considering the fact that there is a pending lack of sand in Denmark.

Doesn't want to be involved yet, too much risk.

The voluntary sustainability classes are too unambitious, they do not make a difference, yes they are used, but the result is the same, but they are the only thing the economy can handle in a country like this where the construction industry is so inefficient and the most expensive thing is the salaries.

A.9 Enemærke & Petersen Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

The company primarily works with renovation in the 'regulated' market, meaning public and half public clients. Additionally, they work with new construction for private clients.

And thirdly, they work in strategic partnerships. These are with Copenhagen municipality and the 'boligforening' KAB. It is a collaboration between architects, engineers, contractors, advisors etc. who are sitting at the same location and are then not making one project, but making many projects with the same people involved, over a period of 3-6 years. With the benefit that the collaboration is much improved compared to standard processes in the industry. This approach solves some of the issues that are to be found in this industry... (see 5.1)

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 Just under 700 employees in all of Denmark

1.2. What is your personal area of expertise? Peder Johansen, Director for customers and marketing.

He has a team which deals with prequalification, deciding what to compete in. Also deals with market analysis. Looking into the tender databases in order to see what is coming and how the market is developing and keeps on top of what is happening in the market. Deals with customer relations, has department chiefs in east and west who are good at going into dialog with the clients about their needs and with the collaboration partners about where to team up. Finally, also deals with business development, looking at all the projects in EP which are not construction projects (upcycling, sustainability, social and environmental, collaboration with research, etc.). In connection with this he is responsible for driving the internal strategy process in EP.

2. What is the core of your company's expertise? Does that differentiate you? The collaboration culture, the strategic partnerships.

The company culture of trying to be at level with each other, not as concerned with the hierarchy and titles, but increasing the feeling of responsibility within in the company.

The focus on creating value for not only the company itself but the other stakeholders as well. They want to contribute in the environment they are a part of and be interesting for the companies they are working with.

The process of developing the project should be the difference, can they improve the experience and the result for the client while working on the project, then that is what they are trying to do. Creating solid and safe processes in developing the projects, which the client can feel. Creating a secure process is an important part of creating a project.

3. When offered new projects how do you decide on which projects you will accept?

Firstly projects are evaluated based on whether they fit the core competences of the company.

When there are many options, then projects are very limited to just what they prefer, but when the market is small less criteria are applied in the selection of the projects.

The other companies in the project is a factor. If there are plenty of good project opportunities, this can be a bigger factor, if there is less options, sometimes they will even work with a partner they are not keen on, because of bad experience or industry rumours.

4. What values are your usual customer segments asking for?

The secure processes, the mutual value creation.

4.1. How do you connect with clients and what is the interaction like?

They do not have that many clients, it is not a mass market. Interaction happens through talking to them. Having people employed who are good at creating dialog with them. Sitting in collaborations and research collaborations with them.

4.2. How is the client involved in your processes?

Very dependent on type of project. When working in a trade contract there is barely any involvement at all. Other types of contracts (turnkey etc.) create a higher level of involvement. The earlier the company are involved the more they are involved with the client. This is what they want, to be involved as early as possible. Even as early as in the plot purchasing.

4.3. Do you have any influence on client decisions? - How?

When early involvement, the influence is big and important. At the moment the influence is used to push the sustainability of the project, regardless of whether it is social, resource or environmental sustainability (see 7.)

5. What determines who you collaborate with? (Subcontractors, suppliers)

Ultimately it's a lot about the price.

When looking at which subcontractors to work with they look at: Competences, who is able to perform the work, Price and (Previous) Experience with the subcontractor.

A.9. Enemærke & Petersen Interview 1 Summary

An important part of this experience is whether they are able to talk to them, whether the subcontractor is willing to collaborate. Another part of this is whether they are willing to collaborate on a social effort. Often they find that they can, especially when the suggestion is framed correctly. When the other companies can see that collaboration will be improved at the cost of few resource hours for example, they are often willing to participate. But it is not possible with just anybody.

But this is not the determining factor in the selection of partners, but the balance between this, competences, solutions, experiences and price determines who the company will work with.

In the strategic partnerships, its different because here subcontractors are investing in the projects early, but with the benefit of not having to compete later in the process. The strategic partnerships are based on a level of trust which is not usual in the construction industry. Therefore subcontractors who they can trust, with good solutions and competences are chosen as partners.

5.1. How do you think the collaboration between the different players in the industry is?

It could be much better.

Some of the main issues found in the industry is the highly divided value chain, way too much law (bureaucracy) and the displacement of responsibility. All of this creates a distrust in the industry. "There is no other business where everyone is this willing to screw each other over."

The amount of arbitrations in Denmark is very high, we drive off the edge together. We [the industry] are behind in a lot of areas. The work environment is one of the worst at all. We have to move as an industry. The industry will say: 'We have done a lot already', true but try and benchmark with other industries and we are hopelessly behind.

But he believes that there is an increase in collaboration within the industry.

"[The business] is headed towards bigger integration" ("Det går mod større integration")

He believes that bigger integration of knowledge in the business is developing, he cannot imagine that anyone finds it particularly interesting to sit in their own office and finish the work and then send it so someone else via email, who will look at it and say what the hell are you doing, instead of meeting and acknowledging each other's business models, and then do as they, by the way, do in other industries, meet and create solutions.

It is already moving in this direction, at least in some areas. Knowledge integration minimises the risks in the projects. The people he talks to about this and the architects who he does this with also think it's more interesting to spend the time like this rather than in arbitration court.

5.2. What would you improve?

The collaborations and strategic collaborations are going to be a big help to the way the system functions, it will solve many of the problems mentioned above.

The things they are learning from the very trust-based collaborations they are doing now is something which can be transferred to more projects and collaborations and which the industry can learn from.

Official structures to enable collaboration and trust-based relations should be a part of the industry (In order to make CE happen). This push needs to come from the government. This could help companies consider all the stakeholders' perspectives, creating processes where everyone is brought together better and create equal terms for the companies to be competing on. Push from the government will be a huge help

Increase the use of Co-location, where architects, engineers, advisors and contractors, etc. are sitting together. This is already spreading, but this will lead to much better collaboration, where it's easier to get answers and keeping other stakeholders' interests in mind.

One step they are currently working on in order to improve the collaboration is starting the project process by doing a collaboration workshop, determining success criteria, how do we communicate, etc.

He thinks that the involvement of the facility managers in the construction process would be a positive step as this could improve the understanding of the use of the building and thereby the design. Mentions IPD, which includes the operation and maintenance perspective into the construction process of the building. Thereby high-performance buildings can be created. It includes: one management, colocation and uniform digital tools.

6. After you finish and deliver a project, are you involved in further processes?

Y: How are you involved?

The company has a service department, which is actually facility management. But it is very rare that this department is coupled up with projects which has been constructed by the company. (See bottom of 5.2)

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Yes

They work with the term in the traditional understanding, social, resource and environmental sustainability.

The sustainability has been strengthened by the 17 world goals. Sustainability in the broadest sense is described by this. It provides a language, so that we can

speak to each other across companies, industries and countries.

8. Are you familiar with the term Circular Economy?

The company has spent the last 2 years on becoming more knowledgeable on what circularity is and what it means for the company at their place in the value chain. (As they don't design) They construct.

They have focused a lot on upcycling, in the different dimensions. Not so much design for disassembly, as they are not designing much. But more, how can they create a business model around harvesting materials carefully and putting them back into the game. Here they have worked with concrete projects. They started a competition among students in 2018. The wining project had the idea to create sheds from upcycled material. This process was started with some partners and the first (50 m2) shed has been finished and set up and the next ones are starting. "This is not fucking much compared to the huge challenge we have, but we have no experience, therefore we have had to start like this."

They have started a research collaboration which developed a circular resource plan. Like a matrix, describing the product, the cost of disposing them, and the cost for carefully harvesting the material, and an expected market price for this material. "This is something to hold up to the industry and say, is there something here we can get better at?"

The company is involved with Stark and a couple of other companies on Sjælland in a project called Gentræ (Rewood) where fencing wood is recycled.

They are currently looking into facade elements where upcycled materials are used in the development of the facade.

"But, honestly, we are in the 'fumble' phase. A system where the market is driving this, I can't see it yet. There are many problems in upcycling. The problem of timing, who is paying for storage between disassembly and reuse. The legal problem, who is responsible for the materials."

"Some large clients are starting to help this. For example, Copenhagen municipality are setting out the ambition now. They are building up storages for these materials, which is possible because they are such a big client. They will store the materials and create a database where the designers can start using them, but for now this only applies for materials such as doors and windows, what about the rest?"

"But it is going to be big [Circular Economy], companies (Real Dania and Innovationsfonden) are willing to push a lot of money into this. That's also needed."

If the public sets up frameworks, then the companies will be competing on equal terms and then this can be pushed much better than when it's pushed from the companies themselves. "Push from the government will be a huge help."

A.10 MT Højgaard Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

Turnkey contractor. >100 years old

Housing, refurbishment, bridges, harbors and structures. Use PPP contracts up to 25 years, where they operate schools. Craftman workship. Revenue of app. 1 billion euro

No work for private clients. Large office construction, and hospitals. 80% revenue in Danish market

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 4000 employees

1.2. What is your personal area of expertise?

With company since 2003. Currently, Head of strategy and development.

2. What is the core of your company's expertise? Does that differentiate you?

Has built most of the offices in Novodordisk, Nordea, etc. Portfolio and expertise. They are just a bit better than most.

They know their strengths and stay in their lane. Focus on their competences.

3. When offered new projects how do you decide on which projects you will accept?

Staying in their lane. For profit. They research the market, follow the market, which offers growth predominantly in the Danish market (the market they know most, it has been growing since 2012). Make sure that the project is within their competences and resources at hand.

4. What values are your usual customer segments asking for?

Understanding the customer, try to repeat customers, 60% of the customers are returning, that is the goal. Tailor to customers, and ask up front what they want, sometimes there is a need to challenge the customer need. Clients are focused too narrowly, on what they need now. They have to be convinced that their needs will change. The company tries to broaden the perspective by nudging and talking about trends and experience, help make the customer understand that a building has to be looked at long term. The continuous change of buildings has to be considered.

4.1. How do you connect with clients and what is the interaction like?

Through tenders, returning customers, but we work quite actively in the market to

make it more modern, and take in new alternatives. It is very rare that a customer comes and asks for calculations and real margin. In most cases the client wants some kind of competition due to the size and cost of projects.

4.2. How is the client involved in your processes?

ABT18 and AB18 are two different models, but we have worked with a number of clients that choose a mix of both. This works best, in our case, we get more suggestions from suppliers and contractors directly to your team, if not, this is a lot of work to pass the information back and forth and the client budget is not met. Collaboration models where people are involved in the early phase and do what we call an early sketch of the project, this combination allows for a selection of criteria for a better result in collaboration. This offers certainty as the ABT system but also allows them to be in the design phases as in the AB system. But this mostly depends on the contract type. Surely, the collaboration models allow for a lot of involvement, and better outcomes. This is done with a transparent process which works best (opinion).

We have different working models, depending on the client.

4.3. Do you have any influence on client decisions? - How?

Some are open to suggestions some are not, sometimes if you have an opportunity to do something differently, we go to the customer and voice this option to see if they are willing to do it.

5. What determines who you collaborate with? (Subcontractors, suppliers)

If we do not have the competences within the company we try to find a contractor with adequate competences and ask them into their team (they might not even be in the competition), sometimes it turns to LOWEST PRICE, but with consideration to the competences, reputation etc. of the contractor /supplier. The technicality of what is to be delivered is taken into consideration. A cheap contractor might be very costly. Usually ask other companies for suggestions.

If you are buying expertise, you might not want to go to lowest price.

5.1. How do you think the collaboration between the different players in the industry is?

It works okay between the companies. "you don't work with companies; you work with individuals." If you have a good relationship people will make the project work, chemistry among teams is important. When focus is on the project, it will usually work out well. But when focus is on defending their own position, it makes them very hard to work with them. The silo approach is the main issue, people working to get things done and just passing it on their results without involving the other players. It is hard working in that way. Depending on the project, it can be okay to go for lowest price. Be careful, if you make the cheapest possible and reduce quality in some places and everybody works in silos and does the same, when the pieces come into place, there will be a lot of holes.

5.2. What would you improve?

Communications, the industry should realise that too much is cost is created in the interfaces. Maybe 10-15 percent of the cost could be saved if the right people are brought into the project at the right time. Earlier collaboration.

6. After you finish and deliver a project, are you involved in further processes?

Usually not, we are looking into doing, which we do with our electrical company, we want to do the maintenance after, but we have to develop further. They finish a project and want to move onto the next.

When they are working with their facilities they should do this

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Very focused on sustainability, part of creating building green council in Denmark. We collaborate with a lot of other players.

When the client demands sustainable projects, they are one of the best companies at delivering, maybe along with NCC, we are the ones that can deliver most successfully on that. We saw it coming and think it is the right thing to do, so we set our lines to work in that way.

There is a lot of focus on energy in the current standards, DGNB and social impact of the buildings, the humans that are occupying the building. But we have to address all the resources, not just those, this is where Circular Economy comes in. We must optimise the use of resources and materials.

We have just started in the construction industry with developing CE. (Book: Building a circular future).

We must look into design for disassembly, use material passports for everything, so future engineers can decide the loadbearing capacity of those elements.

8. Are you familiar with the term Circular Economy?

Analyse and take into account the materials that we are using as an add on to sustainability, it adds to it. For example the standards say that bricks have to be built with cement mortar, but nowadays brick is used for other reasons rather than loadbearing (around 70%), if we change the standard that loadbearing do not need to be built with cement mortar and use chalk mortar, we could take it apart. Same goes for concrete and using mechanical connections.

We were part of the circular house with other 50 companies, and we demonstrated

it could be done. But we have to work with the Danish standard and the European standard.

What are your main concerns in regards to the implementation of CE?

DEVELOPMENT In the industry was a client responsibility

Everyone in the industry are reluctant to go into this because they do not want to take the risk.

The building code, the standards

We need politicians to focus on this

A.11 Scandi Byg Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

Part of the Danish construction industry. Usually works with turnkey contracts, but is supplying the modules themselves.

They work as an industrialised company, constructing the modules that the projects are made up of in factory settings, where they can have control over the processes and the quality of the products, including the materials and the timeframes.

This type of work allows them to work with a higher level of automisation and productivity than what the traditional contractor can usually manage.

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 350

1.2. What is your personal area of expertise?

Development manager, educated a civil engineer. Responsible for development of the product, the processes and the business. He has to support the growth of the business.

Also has responsibility for quality and technics.

2. What is the core of your company's expertise? Does that differentiate you?

The competition for the company is most of the time the traditional contactor. Even though there are a few other who do what the company does it is a niche. They are different from the competition because of the industrialised approach to the construction of the modules, this optimises the processes and heightens the productivity. The fact that the construction industry has almost not developed productivity wise over the last 80 year, is different for the company. They are developed in regards to productivity compared to the industry. The productivity of the company is increasing as time passes. They have focus on continuing to develop the productivity of the company, this will make the product even sharper and make the company even more competitive.

In addition to this the company has the sustainability aspect which they focus on. This has a lot of traction right now and creates a lot of interest in what the company does. 'Svanemærket' has a huge commercial value, there will be even more focus on the green aspect in the future in the company. The profile of the company in the future will be based on being sustainable and innovative. The vision says that they want to set the standard for the future in the industry with an innovative and sustainable construction process.

3. When offered new projects how do you decide on which projects you will

accept?

They have specific types of construction that they focus on because they are limited by what modular construction can do. Because the company is still working within a niche, they have to go out and influence the client to make projects which can be fulfilled by their construction methods. The projects are often gained through networking or otherwise influenced earlier in the process to be developed as modules.

4. What values are your usual customer segments asking for?

Apart from sustainability and quality, which has been covered in the previous questions. The company also still has an attractive price and is competitive in most competitions and they have a good delivery time, which is important for many clients. Because the company constructs efficiently on the factory at the same time as substructures etc. are constructed on site, the construction can be done quickly, and the construct time is highly reduced. Additionally, there has in the company been focus on the connection with the clients and the way communications have been happening. This has paid off for the company as many clients come back, because the company focuses on keeping the client needs in focus. They have a high client satisfaction; which they measure every time they deliver projects.

4.1. How do you connect with clients and what is the interaction like?

A huge part of the customer connections is networking. These connections are made because based on the maintained good relations and the showcasing of products to customers. They spend a large amount of resources on contacting the large professional clients, showing their product.

But they also win tenders.

4.2. How is the client involved in your processes?

Most contact in beginning of the project (turnkey), when the project is formed. Because of the processes of the company almost all decisions must be made at the very beginning. (Because the production happens so fast). It can take 10 day from the construction is started to the first module is leaving the factory.

4.3. Do you have any influence on client decisions? - How?

When they are working on a project which is in tender there are some frames within which they have to work. Here is the most important to be the cheapest as this is the only way to win the project.

When the project is brought to them based on the network, there is more communication back and forth, here a lot more influence can be executed on the client. Now client come to them because of the sustainability aspect, so they can more easily get their ideas through, instead of having to argue for them as earlier.

5. What determines who you collaborate with? (Subcontractors, suppliers)

They mainly work with 5-6 different architects, who know the limits and possibilities in the module construction. The most important thing is that the collaborators understand the product the company delivers. The list of companies with the understanding is expanding.

5.1. How do you think the collaboration between the different players in the industry is?

The construction industry is still a hard environment – especially between contractors and for contactors. Most contractors are aware that they have to take care of their relations to their customers. This can easily hurt the relations between contractors as the relation to the customer is more important. It often happens that contractors have disagreements and thereby bad relations are created. At the same time t is an industry which forgives quickly as when collaborations are needed they will be made. But it is an industry with hard tones. The fact that the company has so much of the value chain in house lets them experience this less that other companies. The more relations you need, the harder and the more conflicts.

5.2. What would you improve?

The way the tender works sets limits for the collaborations. This is one of the main issues. Because of the fact that everything is about price.

The focus ends up being on the price of the construction rather than what is actually important for the operation of the building afterwards.

When they are working with a client who comes into the house, rather than through tender, it is much easier to influence them to construct in a specific way. This costs him a bit (resources in the beginning for involvement etc.) but it saves him in the end.

6. After you finish and deliver a project, are you involved in further processes? No

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Yes,

A lot of people use sustainability as a general expression for the green agenda, for the company sustainability is also economic and social. Until now focus has been on the green, the other aspects will be worked into the company.

Customers focus on the green sustainability for now.

They want to make a comparison between their product specifically and the equivalent construction executed in concrete in a LCA considering.

8. Are you familiar with the term Circular Economy?

Yes

Y: What does it mean to you as a company?

Its "En anden appelsin i turbanen", meaning that, they have achieved it without doing anything for it. Basically, the company business model has been circular by default from the beginning, so the new focus on this is only to their benefit. They provide a product which maintain value at disassembly.

It provides possibilities in temporary construction, in places where less people are moving to, or on temporary plots, as they can be disassembled and moved and reused.

The inability to reuse concrete is a problem.

Y: Are circular economy and sustainability the same?

This is two sides of the same coin. Circular economy should be a part of sustainability

Y (If the company claims to be circular): Where are you circular? How have you accomplished this?

Was circular first, then it became a thing.

Do you think circularity is benefitial?

Yes, it is the future. We (the industry) must consider it and use it. "We can't keep going as we do now"

Do you think it is possible?

Yes, but. There are many aspects in it. The younger generations are more considerate of the resources than the older one. Therefore, new blood in the industry is necessary. But it is slowly changing. There are already industries which are struggling to keep their products relevant and this will continue to develop.

A.12 ALABU Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

The company is a public housing association, their purpose is essentially to rent out reasonably priced housing. The residents own the housing themselves and the company acts as administration for them. There is an organisational board made up of the residents which represents the wishes of the residents. If there is no board, the company does this job.

The company is not creating profit as such, their job is to ensure that everything breaks even.

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250

Around employees 90-100, 70 property administrators and 30 administration employees

1.2. What is your personal area of expertise?

Project manager, takes care of the construction aspects of the company. Renovation and new build.

2. What is the core of your company's expertise? Does that differentiate you?

There are many companies like them. They try and diversify themselves by having some, with the democratic organisational boards.

And through the development of sustainable housing, they try and achieve DGNB certification, to achieve social sustainable 'there should be housing for everyone' by keeping the rent reasonable.

3. When offered new projects how do you decide on which projects you will accept?

Because the company is part of the public sector, somewhat, through the fact that they are a public housing association, they are limited by some frameworks which a private client would not be limited by. These are created to ensure that the rent stays reasonable.

This can limit the ability to construct buildings that are 1. Sustainable and 2. Easy to maintain.

Because of this economy the company is sometime unable to take 'chances' as they are required to make choices on behalf of other and ensure low rent there is not much space in the budget for trying new things, or pushing for example circular economy, if there is no guarantee that the materials etc used will have the same ability and maintenance demands a new ones.

4. What values are your usual customer segments asking for?

The connection to the clients, the organisational board, which actually is the top leaders in the company as they make decisions of how the company is working, and the connection to the department boards.

4.1. How do you connect with clients and what is the interaction like?

4.2. How is the client involved in your processes?

SEE PREVIOUS ANSWER AND ANSWER 1

4.3. Do you have any influence on client decisions? - How?

They try and present the sustainable solutions that can be beneficial for the customers, and to give relevant and good advice about which materials and constructions should be used. The company answers to 'Byggeskadefonden', which means that they are somewhat hindered in making experimental, new or pilot projects.

5. What determines who you collaborate with? (Subcontractors, suppliers)

Tender must be used for everything because of the public frame. Ensures transparency and the 'right' price for the project.

5.1. How do you think the collaboration between the different players in the industry is?

It works pretty well. There is always the relationship between the client and the contractor, where there is economy between, here is the biggest tendency to disagreements as the contractor is of course trying to maximise profit and Alabu is trying to maximise the quality.

Tries to avoid turnkey projects as here they have less control and the contractor has more places to try and maximise their profit. Instead they try to use main projects, this ensures that the company only has to deal with one point of interest conflict.

5.2. What would you improve?

Be more precise in the development of contracts, do not be too vague, be critical of the material suggestions. As a client they have to be sharp.

6. After you finish and deliver a project, are you involved in further processes?

Y: How are you involved?

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

Yes, very important topic these years.

It means a lot for the company, they are part of NBE. A part of that is to achieve new knowledge and inspiration, to be enriched with new possibilities.

They want to become leading in sustainability in Northern Jutland

They are focused on DGNB in regard to the construction, as this looks at the whole process.

The problem lies in the use of reused materials because of the lack of CE markings etc.

They could possibly be part of the input into the reuse cycle, in connection with their renovations. But they are not ready to be the people who actually reuse because of their responsibilities to deliver for the residents of the buildings.

8. Are you familiar with the term Circular Economy? Yes

Y: What does it mean to you as a company?

Y: Are circular economy and sustainability the same?

No, sustainability is a lot of things.

Y(If the company claims they are circular): Where are you circular? How did you achieve it?

N: Present the principle of circular economy

Do you think Circular Economy is beneficial? Do you think it is possible?

Its definitely the right way to go. The time frame is long though, and he sees the current stage as where we are pushing the snowball, to start the process of change. He is skeptical of the circularity (and sustainability) of the current processes (bricks)

Y: why?

At the end talk about why it is important, stating that the EU and Danish government are pushing this system. The Danish government is investing 116.000.000 amount of DKK to further the circularity of the country. And let them know that this is why we are doing the thesis, to analyse the possibility for circularity and if possible try to implement it in their processes.

A.13 Søren Enggaard Interview 1 Summary

1. What do you (as a company) do? (Which roles in the construction process do you handle)

Private client. Developer.

1.1. How many people are employed in your company? 0-9, 10-49, 50-249, >250 7

1.2. What is your personal area of expertise?

Project development, is part of each step of the project process. From plot purchasing to handover of the project.

2. What is the core of your company's expertise? Does that differentiate you?

It is a small company. Have a lot of economic freedom, can do many things without having to go to the bank and borrow money. This means that if wanted, they can purchase a plot without asking.

There is a short distance between thought and action on account of the fact that there are not many employees.

Owns the building during the construction, can decide for themselves, because they have the economic foundation to not sell before constructing.

Based on these factors the project managers have a decision freedom to make on the site.

3. When offered new projects how do you decide on which projects you will accept?

The company is very focused on the location of the development, the infrastructure needed for the buyers.

4. What values are your usual customer segments asking for?

The focus is almost always focused on how the client can create a profit for them. (The location of the building, ensuring the rentability of the property.)

4.1. How do you connect with clients and what is the interaction like?

They get inquiries from possible customers, or they let out the word in the network about the product that they will have available.

4.2. How is the client involved in your processes?

They are sometimes involved. Mainly to push the profit they want to obtain from the project.

4.3. Do you have any influence on client decisions? - How?

Partially, there is a big difference in whether the customers are involved in the development of the project or buyers at the end of the process. The company only influences the project within a tight frame of the economy in the project.

5. What determines who you collaborate with? (Subcontractors, suppliers)

The company mainly works in turnkey contracts and main contracts. They have regular collaboration partners.

The price is one factor. But there is also considerations in regards to the chemistry with the person involved in the project. Meaning that the specific employee and their relation to the project manager from S. Enggaard can be an important factor. The understanding of the other company and the ability to trust them to stick to their word and deliver in accordance with promises and the contract affect the choice of collaboration partner.

5.1. How do you think the collaboration between the different players in the industry is?

There are challenges in the collaboration in the industry. But as the company is a private client, there are fewer problems, as they are not required to tender the projects in the way that public projects must be. This creates less conflicts. With the use of the turnkey contracts a lot of conflicts are avoided, at least for the company, the conflicts may be found elsewhere.

5.2. What would you improve?

The communication in the construction industry could be better.

The agreements in the industry are too vague. Because of this a lot of conflicts are created.

6. After you finish and deliver a project, are you involved in further processes?

Y: How are you involved?

Usually, they manage the buildings themselves after they have been completed. This has increased over the later years.

This has created focus on good quality materials. Because they learn from the places that they in the maintenance spend money, and thereby can improve the quality of the initial elements in these areas and ultimately save money

7. Are you familiar with the term Sustainability? (what does it mean to you as a company?)

They have talked about sustainability in the company. They are connected to NBE, where they have been part of some groups with contractors etc. talking about pilot

projects etc.

Sustainability has been part of the way that things have been done for a long time, the term is just a newer thing, which creates focus on specific aspects. Is very sceptical of the use of the certifications etc.

Pressure must come from the client to develop more sustainable, and certified buildings.

8. Are you familiar with the term Circular Economy?

Is slightly familiar with the term. Understands how the reuse of materials is the centre of the system. The company is not focused on this, and it is not part of the development of the company at the moment. The ask has to come from their clients, or it has to be economically beneficial for the company before it will be considered.

Y: What does it mean to you as a company?

Y: Are circular economy and sustainability the same?

We must work more and more with sustainability (and CE) as a company and as an industry. The world is running out of resources, and that makes this focus necessary.

It is made more difficult because all projects are different, therefore there is a bigger learning curve to implementing Circular Economy in construction, than there is in some other projects.

A.14 Recordings of Round 1 Interviews

See attached folder A.14.

A.15 Table of Categories

Category	Description	Pillar(s)
Client gains	This refers to when a company creates added value to	Optimize
-	the project, optimising the input into the project for the	
	client.	
Client's choice	This refers to the company being open to working	Diversification, Systems
	however the client prefers. This includes multiple	thinking
	viewpoints into the project (Diversification) and the	
	ability to consider the project from several perspectives	
0	(Systems Thinking).	D 1 1 1 1 1 1 1 1 1 1
Collaboration	Refers to choosing partners based on their willingness	Diversification, Systems
wiiiingness	collaborate. This includes multiple viewpoints into the	thinking
	project (Diversification) and the ability to consider the	
Callabaration	project from several perspectives (systems frinking).	Diversification Contains
Collaboration	This refers to the opportunity to collaborate around the	biversification, systems
	(Diversification) and the ability to consider the project	UTITIKING
	(Diversification) and the ability to consider the project	
Collaboration	This refers to the pessibilities for collaboration in	Diversification Systems
	reliefs to the possibilities for collaboration in	thinking
possibilities	projects. This includes multiple viewpoints into the	thinking
	project (Diversification) and the ability to consider the	
Communication	This refers to the company's ability to diversify ontimise	Ontimize
communication	and think in systems through communicating with other	Diversification Systems
	actors involved in the project. Collaborations between	thinking
	players diversify risk and options, creates external input	
	and allows the company to optimise the chain.	
Competences	Competences in collaboration and project development	Systems thinking
	means having the ability or position to look at the project	, 0
	as a whole. This provides the company with systems	
	thinking, as this expresses the ability to think the whole	
	project in as one process and thereby benefit	
	throughout, rather than improving one aspect at the	
	expense of another.	
Contract	The current industry processes, meaning, mostly, how	Diversification, systems
/	the contracts are put together and the effects that this	thinking
Contract form	has on the development of the projects is mostly	
(Current Processes)	negative to the pillars of diversification and systems	
(Public tenders)	thinking, because it forces the companies to look only at	
/	their own profit, in order to make a profit at all. Meaning,	
Contract	not considering the broad benefits to the project and	
formulation	other perspectives.	
Customer	Considered a benefit to optimization, as a focus on the	Optimize
satisfaction	customer satisfaction optimizes the resources spend on	
	establishing the contact and creating reoccurring	
Dosign	Customers.	Diversification (if the
Design	This refers to design as a competence of the company,	decide to use decign for
	into different design approaches (here among sireuler	circular economy
	design) and thereby strengthen the company	circular economy
	design and thereby strengthen the company.	

Distrust	This refers to the hindrances and the negative effects of	Optimize,
	the lack of trust between the companies in the industry.	Diversification, Systems
	This of course leads to inabilities to optimize, diversify	Thinking
	and think in systems, as all require communication and	
	collaboration.	
Dialog	This refers to the diversification, optimization and	Optimize,
U U	systems thinking which can be achieved through good	Diversification, Systems
	communication between companies.	Thinking
Expertise	This refers to the fact that if a company has expertise as a	Optimize, Diversify
. /	core competence it has allowed them to optimise	
Expertise (portfolio)	processes in this area and acquire diverse knowledge to	
	strengthen projects.	
Financial independe	This refers to the lack of need to consider other aspects	Systems Thinking
nce	of the process than what the company itself is involved	, ,
	with. It limits the systems thinking of the project.	
Good relations	This refers to how the company is benefitted in their	Diversification
	diversification by having good relations to other actors	
	and customers, enabling them to include more	
	perspectives in the projects.	
Learning	This refers to the decision to choose a project because it	Diversification
-	creates knowledge. Knowledge allows the company to	
	diversify and strengthen.	
Linear	This refers to the current linear processes in place in the	Systems thinking,
	industry. The current industry processes, meaning,	Optimize, Recycling
	mostly, how the contracts are put together and the	
	effects that this has on the development of the projects is	
	mostly negative to the pillars of diversification and	
	systems thinking, because it forces the companies to look	
	only at their own profit, in order to make a profit at all.	
	Meaning, not considering the broad benefits to the	
	project and other perspectives.	
	The linear processes also have a negative effect on the	
	recycling aspect, as it considers projects as a onetime	
	thing, disregarding the events after construction.	
Networking	This refers to diversifying the company through	Diversification
	collaborations with and knowledge gains from other	
	actors.	
Optimization	This refers to the company focus on optimizing	Optimize
	processes.	
Partnerships	This refers to the ability to collaborate and thereby	Diversification, Systems
	strengthen the diversification and systems thinking in the	thinking
	company through external inputs.	
Possibilities of	This refers to choosing projects based on the	Diversification
project	opportunities they represent and the learning than can	
	be achieved from them. This enforces the diversification	
	of a company.	
Pricing	This refers to the competitive edge of the company,	Optimization
	creating profit and optimizing the resources.	
Processes	This refers to the companies seeing the need for	Systems thinking.

	improvements in the processes in the industry. The current industry processes, meaning, mostly, how the contracts are put together and the effects that this has on the development of the projects is mostly negative to the pillars of diversification and systems thinking, because it forces the companies to look only at their own profit, in order to make a profit at all. Meaning, not considering the broad benefits to the project and other perspectives.	Optimize
Profit	This refers to the company focus on optimizing the profit of their projects. This creates a negative effect on the optimization, systems thinking and diversification in projects as a whole, because of lack of communication with other actors.	Optimization, Diversification, Systems Thinking
Public entities are slow	This refers to the negative effect that the slow processing of projects can have on the optimization of projects.	Optimization
Quality	This refers to meeting the standards set by the client through optimized processes and the ability to create reusability of products due to the high quality and craftsmanship.	Optimization, Recycle
Realisability	This refers to the consideration of the ability to realise the project during the decision process of which projects to start. Early considerations of the project purpose allows for optimisation of processes and inclusion of perspectives.	Optimize, Diversification
Reputation	This refers to the negative effects on diversification that limiting the choice of collaboration partners to only the few that are already know through good reputation. This will limit the amount of perspectives which can be achieved in projects and limit the company's ability to develop.	Diversification
Resources	This refers to the availability of resources and the optimal	Optimization
Sustainability	This refers to the focus within the company on sustainability and the client focus. It affects the design (Recycle and Renewability) and long term thinking (Optimization and Systems Thinking), creating benefits for the company.	Optimization, Recycle, Renewability, Systems Thinking
Tender	This refers to the negative effects the current industry	Diversification, systems
/ Tendering	processes have on the project. The effects that the current industry processes have on the development of projects are mostly negative to the pillars of diversification and systems thinking, because it forces the companies to look only at their own profit, in order to make a profit at all. Meaning, not considering the broad benefits to the project and other perspectives.	LINITIKING
Trustworthiness	This refers to the quality of the company, and how, when it is considered trustworthy, it benefits the collaboration and thereby the diversification of the company.	Diversification

Value creation	This refers to the ability of the company to optimize the	Optimization
	same amount of resources and create more value for the	
	customers.	

A.16 Result of Analysis

Company Enemærke og Petersen	Company Dansk BoligByg		Lendager
Q.2 Cos area of expertise /edge Sustainability Design Design Expertise (portfolio) 1 Caliboration 1 Pricing 1 Pricing 1 Value creation 1 Value creation 1 Statue creation Financial independance optimization	A2 Cos area of expertise /edge Design Expertise (port/olio) 1 collebration 1 folding* Value creation 1 folding* Formanial Independence optimization 1 optimization Renyeability Recycle	Subinvisity and Expension Property 1 Design 1 Description Collaboration Pricing Value creation Learning Financial Independence optimization 1 Optimize 5 Systems Thinking 2 De verification Recryde	1 Costant de exercise / Adapt 1 Costant a la titre 1 Costant a la titre 1 Costant de la titre 1 Optimite 1 Optimite 1 Deversite de la titre 1 Revensibility 1 Revensibility 1 Revensibility
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NIRAS	Company		Company Scandibyg		Company S. Enggaard	
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Appendix B

Chapter 6 Appendixes

B.1 Raw Data Set

COMPANY	PROBLEM	Interview
	Sometimes clients reach out for sustainability with the purpose of greenwashing.	1
	Feels that the contractors and engineers are holding back the innovation, sustainability and circularity in the industry	1
	Limited influence in turnkey projects as the contractor chooses the system early in the process	1
	Contractor is always focused on money	1
	Restrained by technology or costs	1
	The other players focus on building but not reducing material use	2
Lendager	Limited by the nature of the project, if it is sustainable it is not taken on	2
	The industry is very conservative	2
	Feedback meetings but no format or document	2
	In new partnerships other companies collaborate but it is hard to align concepts and approaches.	2
	Regulations are a problem, specially due to their traditional ways, times have changed but not the regulations	2
	Client knowledge and stance	2
	The construction industry has a very high level of risk	2
COMPANY	PROBLEM	Interview
---------	--	-----------
LINK	When winning through competition, the design has to fit the brief, pushing other aspects will add costs and aspects which were not required. It could cause them to lose.	1
	The experience of the company is driving the decisions (the clients trust in the architects' knowledge and experience of what creates a better building (better flow, usespace etc.	1

COMPANY	PROBLEM	Interview
	Projects need to be profitable and	
	learning experiences	1
	Tendering format for some	
	projects	1
	Fixed price contracts limit the	
	amount of time that can be spent	
	on a client (changes require	1
	money)	
	Economy and profit are an issue	1
	Customers dont look at running	
	costs, its just about building	1
	something that is not so	1
	expensive and selling it	
	Open tenders offer more conflict	1
	Distrust and companies just	
	considering themselves and	1
	getting what they want	
	Price driven industry makes it	
	hard to work in and create	
	innovation, a small mistake can	1
	cut your profit margin	
	Price driven industry is an issue	1
NIRAS	Clients mostly look at current	
	costs and running costs, not	
	energy demands, but this is a	
	focus at the moment. People	2
	mostly consider the costs that	
	they will have (not in general)	
	Clients dont really know what	
	they need	2
	Re-design from architects means	
	re-processing for them	2
	Low profits do not invite risk	
	taking	2
	Long -life cycles stifle speed of	
	innovation (maybe look into	
	processes and how to use or	2
	combine materials instead of	-
	using new ones)	
	PPP only considers 20 years	2
	(base themselves on qualitative	-
	solutions rather than quantitative	
	meaning that it comes from part	2
	experiences that are not	-
	experiences that are not	
	necessarily well kept)	

COMPANY	PROBLEM	Interview
	Limited on their selection of projects because of how the market is.	1
	They would like to be involved as early as possible including plot purchasing	1
	Collaboration can be better: highly divided value chain, too much bureaucracy, displacement of responsibility. All creates distrust in the industry. (no other industry where everyone is this willing to screw each other over). Amount of arbitration	1
	Industry is behind in a lot of areas, specially in the work environment. If you benchmark compared to others, we are still very behind	1
	Working in different offices (i cant imagine that anybody wants to work like this). we should meet and understand each other's business models and create solutions.	1
	Official structures to enable collaborations and trust based work should be a part of the industry	1
Enemærke og Petersen	People who don't collaborate, black and white people, there are a lot of them in the industry.	2
	One risk is joining a partnership, and something political happens, and you have to make a rapid change because you have one big customer.	2
	can see there are not a lot of PPP projects, they might run 1 project a year. It is not a huge market, I find it much more interesting in an international point of view, as it turns into portfolio management.	2
	The whole idea would be to renovate or build new buildings, and actually offer the people who are going to maintain it, but the industry is not set up like this.	2
	We would like to have as much possibility to come in as early as possible	2
	It is a symbol of something, it is a start, we can not just sit and point to others. We need to do something. It has been the same argument for a hundred years	2

COMPANY	PROBLEM	Interview
	Clients are too narrowly focused on what they need now	1
	They work through tenders	1
	Without a mix of AP19 and APT19 it is	-
	hard to pass on the information back and	1
	forth from contractors to clients	-
	Constriction by contract types	1
	Clients are not open to suggestions	- 1
	cherits are not open to suggestions	-
	If there is a need to subcontract it may go	
	to lowest price, but usually considers	1
	competencies and reputation (this is not	-
	great), and technical difficulty of task.	
	You work with people not with companies	1
	Trust and people defending their position is an issue, and the silo approach	1
	Making things cheaper here and there is a problem when all solutions are put together, we dont necessary know where everyone cut costs.	1
	Communication is an issue, there is too	1
	much cost associated to the interfaces	-
MT Høigaard	The safest approach is bullet first then cannons	2
in hyjgaara	Industry division (5 really big contractors,	
	20 smaller ones and then smaller and	
	smaller until one man company).	
	Development has to be with the	2
	integration of engineers, architects and	
	such. Teams working from different	
	offices	
	Clients look at cost/benefit from 5-10	2
	years, but buildings life cycles are longer	2
	Traditional public industry thinking, the developments do not meet the users needs	2
	Low profit margins are an issue	2
	Public clients dont necessarily think about	
	investing more at the moment to save in	2
	the future	
	Subcontractors dont mention their	2
	innovative ideas to main contractors	-
	Short-sighted ness	2
	Not enforcing the thought that buildings shape the way we live (health issues)	2
	PPP does not take CE into consideration (it only considers 20-25 years)	2

COMPANY	PROBLEM	Interview
	Have to influence the client to use thier types of produccts	1
	It has to be proven the methods work before others trust it	1
	Limited in who they can work with, because they have untraditional methods	1
	Industry is a hard environment, hard tones	1
	The focus on maintaining good relations with clients can hurt relations to other contractors	1
	The more relations you need, the more conflicts	1
ScandiByg	The way the tender works sets limits for the collaborations. This is one of the main issues. Because of the fact that everything is about price	1
	The focus ends up being on the price of the construction rather than what is actually important for the operation of the building afterwards	1
	The biggest challenge has been to convince the other actors, architects, 'byggeskadefonden', etc. that it was a good way of building	2
	If you are not competitive on the price in the market, then you are not representative	2
	Its harder for a 'normal' contractor, who takes on main contracts to have any kind of influence on the client and project choices. It depends on the contract type	2
	For a normal contractor to reach circularity: There will be larger managing costs, more communication is needed, some sharply defined project, contracts etc.	2

COMPANY	PROBLEM	Interview
	The price is one factor	1
	The chemistry with the person	1
	involved in the project	1
	There are challenges in the	
	collaboration in the industry	1
	mostly connected to public tender	1
	rules	
	Many conflicts in the projects	1
	The agreements in the industry	
	are too vague. Because of this a	
	lot of conflicts are created	1
	skeptical of the use of the	
	certifications etc	
	Pressure must come from the	
	client to develop more	_
	sustainable, and certified	1
	buildings	
	CE has to be economically	
Søren	beneficial for the company before	1
Enggaard	it will be considered	
Luppadia	It is made more difficult because	
	all projects are different,	
	therefore there is a bigger	
	learning curve to implementing	1
	Circular Economy in construction,	
	than there is in some other	
	projects	
	Does not know of design for	
	disasembly and material banks,	2
	lack of knowledge	
	No processes for feedback and	
	information sharing	2
	Information sharing	
	The maintenance and operation	
	of the building over time costs	
	much more ultimately than the	
	construction. Therefore this	2
	should be considered. one	
	problem is that this is not	
	considered now	

COMPANY	PROBLEM	Interview
ALABU	Limited by contract form	1
	Tender for everything	1
	Lack of guarantee on materials (for reuse), not CE marked, the dont know if they have the same performance, don't know what the maintenance requires, they answer to the byggeskadefonden	1
	Relationship between client and contractor because of the profit and quality (both try to maximize it)	1
	Avoids turnkey because they have less control, but this means they also need to put more time into each project	1
	They would like the industry to improve in the precision of the developed contracts.	1
	Quality and risk of reused material	2
	No feedback loops, they have a user board	2
	Hard to implement recycled materials, government must find a structure for certification	2
	Limited framework will create some pressure to become more circular, or recycle more, which is hard if you can only have so many options, like crushing concrete	2
	There is no model for a circular company or business model that they can work with (so far), being part of the NBE	2

B.2 Lendager Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

We have also assessed that according to our metrics you are one of the leaders in circularity practices according to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You are leaning more uniformly on all pillars (compared to the other companies) but more heavily towards the pillars Optimise, and Renewability because of your processes, reuse of materials / products and approach to create circular projects.

We found that your company has a unique business model/stance, where you, operate as a usual architecture firm for designs and on-site advisory, but you have the sustainable approach, which helps you have a unique approach toward projects. In addition to this you have the upcycle department and the TCW department.

1. Which steps/approach did you take to locate your company in this stance? Which branch of the company was the first to start (ARC, TCW or UPCYCLE)

Arc main, still the biggest one, upcycle is a side project helping arc, and now approach is to sell project to sell out to others where you sell what you get from arc. TCW works from outside of the construction industry as well, they can take in elements from other industries

Upcycle should support arc in the beginning, is now developed to be an independent company

Did you start as sustainable designer firm or as an on-site supervisor?

Architect firm, it was idealised as a one-man consultancy, then it just grew out. There is a market for a complete architectural firm.

2. Based on your previous reply. At which point / Why did you decide to expand your business into these branches? What was the reasoning behind it?

Demand and possibility to expand, bigger projects coming in and availability of specialised people. Like atcm, up and arc are a little bit together.

Do you plan on expanding this business into another area?

Classified, no 4th branch, but some collabs coming up. Maybe come up with a new business model. Market is growing, hiring people maybe.

Generally, according to the studies and the conducted interviews, we can say that there are a lot of problematic contact points, between actors, within the industry. These contact points make it more difficult for companies to become more circular. Most of them refer to interaction between actors in the industry. In your case, the number of contact points is reduced, and you mostly deal with clients and contractors.

No projects with no circularity, so it are less contact points.

You talked about the limitations in the collaboration side, because of the strategy and interests of other players in the industry (not all are interested in sustainability, most care about profit and easy solutions). This type of issue is relatable to attaining circularity (diversification, circularity pillar) in any project, as here, the choice of companies to work with and clients are limited, therefore:

3. What is your current strategy for overcoming this communication issue?

Set up ground rules early in the process, everybody will know how it will work and what the focus on sustainability is (materials, dgnb, what's the main focus?) all projects have different focus, and what the client wants, and what the contractor can do. 80% turnkey

How do you push the contractor? - prove of profitability, etc

Why did you solve the issues in that way?

What was the reasoning and benefits of going in this direction?

There is no other approach, along the process to convince contractors to work a different way. This is hard, due to conservativism?

As the clients are your main contact point, and the one that has more decision power. We understand that you need to establish the idea of creating sustainable designs early in the process. As we talked about last time, you are now more and more, approached by clients who are seeking more sustainable solutions. However, for much of this, additional costs are still connected to the project development.

4. How are you currently trying to influence the clients to create more sustainable brief designs?

Early in the process, before the project is developed. Advisory, for the client. Spend more resources on the get go

Have you tried to take in new business using the optimisation or long term costs approach? (maybe bim tools?)

Story of older buildings, circularity or sustainability as a marketing tool. People are seeking out this type of projects to rent out/build.

5. We have also established that within the industry, the further along you are on the process, the less influence in decision making you have. Therefore, your unique position as an Architect means that you have certain amount on influence with the client due to your location in the chain.

Have you had trouble convincing the client? Is it hard to give input into a project and influence the client into going in this direction? How do you usually go about this?'

Your approach demands constant development of the company and continuous learning.

Your design approach (sustainability) requires some extra effort convincing other actors to work in different ways. And since most projects are different, as well as the people you work with, you tend to learn from each project about what could be done better or differently (regarding processes and communication to other actors).

6. How do you attain and spread this knowledge?

People sitting gain some experiences that they take into new projects, we also try to share open knowledge, and use it in the next project. Strategic and production wise

Do you have feedback loops? Tools?

Mainly its meetings, no documentation. Talk about issues - should the solution for them be a way to document learning and creating a way to share the way things can be done, both internally in the company, but also on site. Standardising some of the processes more.

Who would you involve making this process more efficient?

Everybody, its not efficient but it is the way it should be

How do you approach spreading the idea of circular construction?

Couple of hours where we share projects and speak, internal speaker talking about relevant topics. Sometimes external professional, how to do things smarter or more sustainable.

Sharing information of how to perform certain constructions from one project with one contractor to another

If the contractor develops processes while working with them, which can help another contractor in another project. - share that information Dialog of sharing – mouth to mouth

7. How do you consider main contracts compared to turnkey contracts?

B.2. Lendager Interview 2 Summary

Main contractors come later in the process, sometimes if they are big companies, we can push the envelope. Turnkey comes really early in the process, its easier to push the agenda if it's a main contract setup. If you build with public clients, they are more keen on working the old way? (not sure), and they mostly use turnkey.

Does turnkey limit your ability to create sustainable projects?

Yes, already answered.

And how do you consider PPP or new partnering, for your process?

PPP may be better to get sustainable projects, should be looked into.

New Part, in general the architects are good, but in general sustainability their goal for sustainability is lower than ours. They have a different approach to sustainability, (lower sustainable standards). Building efficient is seen as sustainable, but it should be also about resources.

Do you consider these processes a benefit to the project and the circularity? More difficult

Would these decrease your influence on the project?

Would create more diversification for the company, as more actors is involved in design.

Do you consider this a benefit?

Or does it make it more difficult to push circularity as much as you aim to? Have you analysed the possibilities? Why would it work/not work for you? Arc company: vandkunsten

What is your process in regard to designing circular?

Some projects: the circular building site, building to be taken down and we re-use the materials, materials would become a big part.

Materials are a big part of the design always, if its wood it can't be higher than 4 floors, same considerations for other materials.

Regarding flexible building design how do you prioritise the design needs between quality and recycled materials?

Varies from project to project. Client wants are taken into account. Sometimes its expensive to do this

How do you asses the usability of recycled material.

TCW is a big part of it, they have to be tested and inspected to make sure that it builds up to regulations

Do you focus on design including recycled materials, or do you go through the circles and ensures high quality first, then adaptability etc?

There is a big focus on the building should look like one thing. We try to do both, Rows is an example, doing the bricks combined with thinking very circular, how do we dispose of the building, sometimes it's how to use them right now, and not so much on next time. It would be ideal to consider now and after.

We have found that establishing circular practices is a complex task by itself. But it poses additional difficulty regarding selling and developing circular projects. As you are a front runner in this industry, you have had more experience than most in this area.

8. What have you experienced to be the main issues while trying to undertake this task? What are the hurdles that you have faced?

Regulations, - the concrete industry and insulation industry are very powerful.

Client, they don't have knowledge, its easier to convince a regular person than a professional

Risk is very high in the industry, the demands for buildings are a totally different level

Which issues are currently the most important? Which areas do you see being an issue while trying to develop circularity practices in the industry?

B.3 NIRAS Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

We have also assessed circularity practices according to the 5 pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You are mostly relying on Optimise, and Systems Thinking because of your good collaboration formats, thinking long term into the maintenance of the projects, and learning capabilities.

As stated previously, we found that your company has a unique business model/stance in that you are, differentiated through your competencies and expertise, as well as the fact that you, mostly, do consulting, giving you a lot of influence on the clients, which helps you have a unique approach toward projects and the ability to control and choose the processes.

1. What were the main motivators for adopting this business model?

We need to look at news ways and new fields of expertise, and we always have to in order to keep up with the rest of the world, development is our standard consultant fields and new fields. We need to make a business. We also have a responsibility for doing sustainable consultancy. And third, we would like to attract the young and most competent employees, we need to do what is interesting to them.

Did you start as a specialty company and branched, or did you always intend to have all expertise?

Organic evolved, it has grown from nothing to what we are now. We started as a 2 person consultancy firm in Greenland. Within the building consultancy we are trying to move ahead and broaden our competences.

Do you plan on expanding this business into another area (CM, or is it just a test, maybe FM)?

We have this actually, a big job on doing construction management. Actually, we have had a few people with the competences and hired a few new people, we could see there might be potential in the future for that area, to build a strong organisation. When the project is finished we believe we will be very strong in this area.

Does your focus on expertise and competencies add a pressure on you to remain ahead of the knowledge in the industry?

No, I don't think particularly from other companies, but from our surroundings yes, we need to move forward. As well as our employees would like to move ahead.

How do you approach this?

If so, does this include circular economy?

We have seen some push toward the circular economy, but just a little. We still struggle to get a grip and get it going as a field of expertise. We have developed a tool for building projects that looks at the number of SGDs which is capable of quantifying them, to establish a dialogue with the customer, what would they like to achieve. It is still difficult to get a hold of that.

As the clients are your main contact point, and you need to establish the idea of delivering high performance projects (in the brief design).

2. How are you currently trying to influence the clients to create alternate solutions to the initially proposed?

It differs, some clients want us to come with alternatives. Others don't realise they are not sure what they need from the beginning. Most commonly we look at the energy demands and options for sources. This is the level of discussion at the moment.

Is this efficient?

What clients need are some simple calculations that we can do and share with them and show the consequences or maybe a catalogue of calculations where they can see the effects and decide. We do this from what we call reference assumptions. They pick what they want, we do this with the client and contractor if possible. And then we assess the cost.

You mentioned last that even as clients approach you and ask for opinion and advise, the determining factor usually ends up going back to the money involved.

Does this extend to costs in the operation of the building as well, or is the clients usually more concerned with current costs (if more money spend now can save them money in the future)?

Mainly we discuss current costs. It depends, some of them are interested in the long term as well. But the two different types of running costs, one is energy consumption. That is always the person who lives in the building or the user. Then there is the maintenance, most often the owner of the building is involved there, so if they are interested in minimising this, they consider it. Energy consumption is of no interest to the owner. For example, the pension funds currently are willing to

invest in sustainable housing, interested in a low energy building than a standard building. They are also interested in DGNB, and different certifications.

Additionally, you mentioned that for your clients it is often the case that they build it and sell it, they sometimes don't care what are the running costs, they just want a building that is not too expensive.

Do you find that the disconnect between the client building the building and the end-user creates issues in the opportunities for developing the processes and innovating in the industry?

It is difficult to change. But we know from real estate agents, that within the last years, houses with better energy class, have higher prices, they are easier to sell. It is becoming more interesting; people are interested in investing in such housing. It is moving towards that direction, but it is slow.

Do you see any process changes, management tools, which could aid this?

We know that investors are tending to become more interested in sustainability and certifications. That's maybe where you want them. Otherwise, we need to make it more attractive. The issue is that most often, the end-user is the one that influences energy consumption. Maybe the fixed amount that you pay in rent, if it is quite high the amount that I can save is too small (in my opinion). It could be the structure that could be changed to incentivise the energy usage of the renters.

You said in the last interview that one of the motivating factors in applying for a project is the opportunity to learn from it.

Why did you adopt this model?

Because we want to make money, that's one side. The other side is the want to learn, we are ambitious, we want to make the next project a little better, and we want our employees to learn and be better, thus attracting new talent into the company.

How do you learn from it and make sure you keep the knowledge?

After we finish a project, we have an evaluation meeting, a brief meeting where we discuss the good and what can be improved. Some we can handle ourselves, some of the things we need to discuss with our collaborators. We also have evaluation meetings with our architects and contractors to discuss what went well and what can be improved and get opinions. We have a note from these meetings, and we bring the conclusions for the next projects.

We have project status meetings on different periods, which is set by the type of

project. We meet whenever it is necessary, we are very aware that it is a status meeting, so they should be short, like half an hour. If something needs to be discussed it will be done afterwards.

PMs are part of a network, and branches are linked through this, they meet 4-5 times a year where they discuss and exchange experiences, that is also how we get good knowledge from other offices. We have templates on how to do project management.

Generally, according to the studies and the conducted interviews, we can say that there are a lot of problematic contact points, between actors, within the industry. These contact points make it more difficult for companies to become more circular. Most of them refer to interaction between actors in the industry. According to our last interview you see that open tenders have more issues than closed or invited ones

3. What is your current strategy for overcoming this issue?

We start out with a meeting, including architects, clients and maybe contractors. This is done to outline processes and time, this is done to discuss how to proceed and to agree on expectations. We have a written agreement on how to do things. The contract outlines what should be done, but we need to establish the processes for it. We often experience that the architect keeps working on the design, so we have to re-do our designs, that destroys our work, thus we like to lock in the original agreements on how we will work. It is very important for us. We try to work through the project phases, it's seldom where we have a project with these exact phases, but we still try to work in this way and explain what we need at what point and what should not be changed after what phase.

Would communication tools be able to ease the communication issues in the industry, or do you believe that a more deep-rooted solution is necessary? (you mentioned earlier communication, but this is currently hard)

The best way to go is to agree on a tool or a process. I don't think our processes are unique, our competitors do more or less the same

You also discussed the low profit margin for many of the actors in the industry. This limits their ability to innovate and take chances on new methods and take on risk. (that the price driven industry makes it hard to work in and to create innovation, as a small mistake can cut your profit margin, that it forces the different actors into being very narrow-minded of their own business, meaning that there is not so much motivation or willingness to develop the process.)

Would monetary incentives by themselves be sufficient to push the industry

towards innovation?

I think it would help us. We have a small yearly turnover, so we don't have the ability or can't afford to take much risk. So, if the profit margin was larger, we would be able to do this.

What else could possibly help?

I think that for us, the most important thing would be to more effective in the way we solve our projects. For us, the answer to making a bigger turnover lies in the process. We are not as efficient as we could be. We spend a lot of time re-doing things.

Risk is also an issue; it takes a lot of time to verify a material that can work. The building industry is very conservative, but this has to do with the life-cycle of the products. Maybe instead of thinking of new materials, we should think of new processes or new ways of using existing materials. Or combining materials in a different way.

4. In the realm of expanding the industry, which possibilities do you see in using PPP contracts, in regard to implementing circular economy?

Have you analysed the possibilities? No, I haven't

You talked about, last time, how you as a company, look into maintenance and running of things that come after construction, "we do construction that requires little maintenance, that is the target we agreed to go with, in order to be more sustainable."

How do you find that this resonates with the clients?

Most often it could be a requirement from the client. That is a part of the running cost, so they actually have to handle it. They are more interested in maintenance than energy. Most often they want low-cost solutions.

How do you determine what construction / which quality of material will help you achieve this goal?

It is based on experience, more or less. We know that bricks can last for a number of years, we also know that if you have a painted surface you have to maintain it. It is not a quantitative analysis, its more qualitative and based on experiences. We also know that from different customers they have different needs. From contractors, we know that there are a lot of ways to install a window, but then again sometimes they don't like to install things differently because it can take more time or to deliver it properly, but this new way makes it more energy efficient. It is an experience that we bring on from clients or customers.

B.4 Dansk Boligbyg Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

We have also assessed that according to our metrics in circularity practices according to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You are focused mostly in the areas we classified as Optimise, Recycle (sometimes on the concrete demolition projects), and Diversification.

As stated previously, we found that your company has a unique business model/stance in that you, only supply the management to the projects, and thereby hire subcontractors to perform the construction. This gives you a lot of control over the process, but also a lot of collaboration partners.

1. What were the main motivators for adopting this business model?

Gives an agile company. And other incentive. At the combination of a management company like ours and a carpenter will result in two different opinions and businesses, which can result in rather severe 'gnidninger' within. As they only manage, they can say that no contractor will be able to take control of a project. Also they are more competitive on price as they can choose lowest bidder on all projects rather than being married to one contractor. We think that we are better off. It also creates more pressure to be good at the job they have.

What do you see is the benefit/downside of only managing Why do you mostly take turnkey contracts?

Do you plan on expanding this business into another area? (partnerships, subcontractor departments, facility management)

What would you consider if you decide to expand your business like this?

They are careful in how they may expand the buisness. They do not want to start own production, meaning hiring contractors. And they do not want to develop into the area in which their customers are, in order to not become competition with these and 'step on their toes'.

They already do partnerships and PPP projects to a point. They will for example co fund developments etc.

Hurdles in the industry and c ompany in regards to implementing Circular Economy.

The industry is very concervative, this results in it being hard to develop new

processes. This is furthered by the pressure on money in the industry, and how it makes companies unwilling to experiment and try new products. (MGO plate). If the material is untested, the contrator is too much at risk.

You talked about the limitations in working with other companies due to the time of entry into the project, as well as the issue with the economic focus in the industry where people are more concerned with making a profit than anything else. Collaboration issues like these are found everywhere in the industry and are associated to attaining circularity (Optimise and Systems Thinking, circularity pillars) in any project, as here the choices of who to work with, and how to consider other players in the project, is difficult, therefore:

2. What is your current strategy for overcoming this issue?

You mentioned that you try to establish new relationships and work with new companies What are you doing to achieve this?

What are you doing to maintain relationships?

It's a small world, the word about how the company is spreads. They try to behave properly. The most important thing is to maintain their good reputation. If you get a bad reputation in this indutry, it becomes very hard very quickly.

As we just talked about, according to the studies and the conducted interviews, we can say that there are a lot of problematic contact points, between actors, within the industry. These contact points make it more difficult for companies to become more circular. Most of them refer to interaction between actors in the industry. In your case, the number of contact points is large (manufacturer, architect, client, subcontractors), but since you are hiring the people you work with, this allows for some control over the process:

3. Is this model what allows you to optimise, or could your optimisation be achieved if you were only hiring based on lowest price? (cost of bad collaboration). Why? Benefits and consequences

Make sure to do things in the right order and manage the other companies in the project properly. They have to look at the tendencies in the market and make the contracts when the market is up and buy in when the market is down. However, when they manage this, the pressure is higher for the subcontractor and they will be harder to work with.

We do not deliver more than what you are buying.

In the interviews and research, we have found that many actors with similar contact points as yours have a hard time collaborating and working as a system. But from the information that we gathered from our last interview, you have a focus on establishing and making these collaborations work more efficient and

effectively.

4. What do you do in order to improve the collaboration in your projects between you and other actors?

They try and involve subcontractors early, when theyre making the initial plan for the tender project. They are talking to the sub contractors about the pricing in the beginning, but not really for the design etc. Especially the technical contractors are connected to the project early.

The collaboration is also in large part dependant on the people factor. Some project managers and sub contractors work well together, while others juust don't. This is a factor which is hard to prepare for. The human factor has a large impact. They try to have respect for the business of the subcontractors.

What would you suggest to other contractors to tackle this contact points problem?

What do you think are some of the consequences of implementing this solution? In regard to the circularity aspects mentioned in the beginning of the interview, (some) pillars remain as possible future focus areas for the company: Systems Thinking, Renewability and Recycle. Systems thinking refers to incorporating the full project process into the thinking of the project. One way of developing this is to looking into fx PPP projects. Or including the demolition waste into new projects as they are designed in your turnkey projects.

5. Have you tendered for, or considered to tender for PPP projects?Have you analysed the possibilities?Why would it work/not work for you?They have. But are not focused on it.

Recycle refers to recycling or upcycling materials that you work with, it might also refer to reusing processes or information obtained from previous projects. Are you using any tools that may aid these processes?

Have you considered other alternatives?

Do you see any future opportunities to go into these areas?

They have some processes that they try and use in projects which are similar to each other. The reuse of the processes is a safety factor for the company, because if they try to do the same, they know that it works. This is especially true in the design phase.

To improve the Diversification of the company, you can use the ability you have to work with all types of companies to learn from their processes and be ahead in considerations made by others in the development of circularity.

Systems for information exchange with reoccurring collaborations Systems for information storing that can be used as a reference for future projects. Feedback loops, from clients and subcontractors

They stick to the tender portals. They choose ajour if they can choose.

He finds that there are too many systems, they use 8-9. It depends on the other actors in the project. It demands a lot of resources and trouble to switch between the systems.

B.5 Enemærke & Petersen Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective). We have also assessed that according to our metrics you are one of the leaders in circularity practices according to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You are leaning towards the pillars Optimise, Diversification and Systems Thinking (more about potential than actually doing it) because of strategic partnerships, trust, and collaboration principles. As stated previously, we found that your company has a unique business model/stance in that you do strategic partnerships, giving you a lot of understanding on how to work in teams and collaborate, especially considering that you have the teams set up in the co-offices as previously explained.

1. What were the main motivators for adopting this business model?

I think the main motivation for going into partnerships or long term trust-based partnerships. You simply have a lot better frames for production. You have a much better opportunity to think in terms of industrialisation, it is repetition. So you can look at your production processes, and ask how can we improve the next project. I believe we can improve the basic gain of the project, but young people have a better work environment if we have improved more than problems.

Did you start as a normal contractor and went to strategic partnerships after? We started as a carpentry company.

What was the incentive to go this way?

Our collaboration DNA, we had all the competences to go into a room and solving the problems and conflict.

What risks do you find are connected with this model?

People who don't collaborate, black and white people, there are a lot of them in the industry. One risk is joining a partnership, and something political happens, and you have to make a rapid change because you have one big customer. You also have to diversify, you can get boxed in.

Do you plan on expanding this business into another area? (you mentioned you studied circular economy, do you find a lot of potential to this? Maybe PPP) Definitely see potential in Circular Economy, there is a lot of confusion, we are

in a phase where there is greenwashing, but we need to go through and find a more stable position. One area is all our resources out there (garbage), there is an easy solution for glass or concrete, just put it in the right places. Companies will recycle and get a new stamp so there is no problem with building it in. There is a huge potential for the industry to join and get the most out of this upcycling. But when you talk about upcycling from one building to the next, who takes the responsibility? We need to make some progress.

I can see there are not a lot of PPP projects, they might run 1 project a year. It is not a huge market, I find it much more interesting in an international point of view, as it turns into portfolio management. In Denmark PPP is all about financing.

LONG TERM TRUST BASED PARTENERSHIPS, Much better frame for production,

Create recyclability of processes

You mentioned last that the involvement of the facility managers in the construction process would be a positive step as this could improve the understanding of the use of the building and thereby the design. (Mentioned IPD) Are you looking into expanding the business in this way?

Yes, we have tried for several years to try this service. The whole idea would be to renovate or build new buildings, and actually offer the people who are going to maintain it, but the industry is not set up like this. We have not been able to make a big business out of this. We are a very very small player. You have big FM people and then you have the guy next door who has a van and can deliver for half the price. What would it mean to re-use, what would it mean for the players? We need to establish this discussion, it's like we have two life cycles.

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2. As your strengths in the company are tied to your expertise and knowhow in regard to the types of projects you do, do you find that this puts additional pressure on you as a company to develop your circular competences?

Yes there is, but I would like to have more pressure. This is something that is peculiar, who has the competences, the knowledge, the power to go out into market with this. Some people can offer the possibilities within a project, if you can standardise this, you can replicate it. I would like to integrate this kind of knowledge in this business. We have to get started somewhere, we need a large scale, not on niche markets, that is nice, but we are a big industry.

For you, security in the reuse is important.

When you are working in strategic partnerships you choose collaboration partners who you know you can trust and who has good solutions and competences. 3. What can a contracting company do to develop a more collaborative model if they are underlain public tender and cannot choose who to collaborate with? Push the responsibility, nobody wants to take responsibility. But it depends on who is in the marketplace and which type of contract. We would like to have as much possibility to come in as early as possible. Tender with negotiations would be good in the beginning, its better than the traditional one.

Last time we talked about a couple of different hurdles which are connected to the implementation of circular economy in the construction industry.

Firstly, we discussed the divided value chain and how this creates too much bureaucracy and displacement of responsibility. All of this creates a distrust in the industry. And results in a very high amount of arbitrations. CE is based on a necessity for communication and collaboration.

As a company, you are differentiated by your collaboration culture. You have developed collaboration models which enable you to have trust-based collaborations.

4. How do you try and overcome the distrust which is present?

It is almost like the same leadership tools that you have with any organisation. We have people coming from different places with a company identity, and make them a hybrid organisation, it may be temporary, but a new identity is necessary.

What are the issues in developing this model?

It means dealing with a new organisation, to get groups to work as teams. You need to talk about collaboration, conflict resolution abilities, interpersonal competencies. This is what is needed everywhere else

What issues have you faced?

Company identity, behavioural values. Classical rhetoric, sending emails while being in the same office and that kind of things.

You mentioned that you work with some companies, and that it is not a mass market, but trying to extend the list of companies that will consider this style of work

What are you doing to achieve this?

We have a profile in the market, and networking, discussing with different partners in the industry. Attending meetings in the Danish Building Association and such, philanthropist organisations, anything we can find where we can push to create a wave that goes in this direction. To create change, you can not do that alone, you need to connect to the whole value chain.

What should be the first steps for other companies to develop more trust in their processes?

You might create a company in the company, it requires a certain mindset to work in that way Generally, according to the studies and the conducted interviews, we can say that there are a lot of problematic contact points, between actors, within the industry. These contact points make it more difficult for companies to become more circular. Most of them refer to interaction between actors in the industry. In your case, the number of contact points has been augmented.

5. Is your collaboration model what allows you to be sustainable/circular (diversification), or could your circularity be achieved if you were applying a usual work approach?

We work in all type of collaboration forms. Total contracts, strategic partnerships, and others. We are a company divided into many rooms. We do have a lot of different contact points. I believe that we need to drag the people who are putting out tenders, we need to inspire them by showing solutions and mobilising our own organisation.

What would you suggest to other contractors to tackle this contact points problem?

Mobilise your companies, offer solutions, mobilise your company.

What do you think are some of the consequences of implementing this solution? Is this efficient?

It is a symbol of something, it is a start, we can not just sit and point to others. We need to do something. It has been the same argument for a hundred years

Last you said that official structures to enable collaboration and trust-based relations should be a part of the industry in order to make CE happen. This could help companies consider all the stakeholders' perspectives, creating processes where everyone is brought together better and create equal terms for the companies to be competing on.

6. What can be done from the governments side to enhance this?

Should it be controlled through regulations, incentives or ...?

What they could do, is be an example themselves. Municipalities are clients, they are talking about it, about strategic partnerships, and have made some. Legislation might close down the market a bit, but we have received tenders that are IPD based, or team enterprise.

The government should be an example

To improve the Diversification of the company, you can use the ability you have to work with all types of companies to lear5n from their processes and be ahead in considerations made by others in the development of circularity, do you, and to which extend do you, uses any of the following: Systems for information exchange with reoccurring collaborations Systems for information storing that can be used as a reference for future projects. Feedback loops, from clients and subcontractors

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B.6 MT Højgaard Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

We have also assessed that according to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience) MTH is doing well in the Systems Thinking and Optimise pillars.

We found that your company has a unique business model/stance in that you, mostly, do turnkey contracts, giving you a lot of control over the process, especially considering that you work with project categories (such as schools and hospitals) which you are familiar with. Sticking to your own lane. You mentioned that you focus on your competences in the company.

1. What were the main motivators for adopting this business model?

How do you think the company would fair working within new frames (different project types)

If the project type specific expertise is not beneficial

I think that we are doing is that when you look at circular economy we are still at a very very early stage, we are in the first flat part of the S curve of development, we are there on the industry in general so it's very difficult to estimate the market potential and so on. The ideas that we can realise in the future have not been thought of as of now, anywhere in the world. When everybody starts to develop in this direction a lot of new ideas will come, I think you will see a world that will be quite different from the one we have today in just 10 years. As we also discussed the sustainability went through the same S curve.

Our business course is that we see and realise that the construction industry and the companies there will have to be able to offer quite a lot on the circular agenda in the years to come. We won't transform the whole company, especially not when we do not know where to go, so what we are doing now, we are trying to look at the competencies we have and see how we can apply them to become more circular in whatever we do, then we engage in projects such as circular house, where we are doing experimentation, where you walk much further ahead than the average in, we do experimentation we are walking further ahead just to see whether this is the right direction to go, "shoot bullet first then cannons", only if you hit something you pull the cannons. We have a kind of gross matrix which we use for whatever we do, it has to do with unique competencies, competencies, markets and customers, and the other corner is the considerations we have to make. ((Look at matrix include it in the project 'Profit or Growth' book)). We develop skills that will be applicable for the future, we have an idea of where the future goes. Getting new customers and new skills should grow your company.

2. As your strengths in the company are tied to your expertise and knowhow in regard to the types of projects you do, do you find that this puts additional pressure on you as a company to develop your circular competences?

No. Because we have always, even though when you look at this industry, even if this industry is dull and not much has happened, it has been slowly progressing. It has developed a lot over the last 30 years, just look at energy efficiency, we have reduced the consumption it by a factor of 4, in the car industry the efficiency of gasoline to kilometers over the last 30 years they have only done half as good as we have done, including more money into the development. Same as advancements in areas such as safety.

Consider time Vs complexity on standardisation, which is inverse to the manufacturing industry, you can see that standardisation while help the industry turn into the manufacturing industry, manufacturing is going into customisation, we go from very specific to a simplification which will make both intersect at some point.

Generally, according to the studies and the conducted interviews, we can say that there are a lot of problematic contact points, between actors, within the industry. These contact points make it more difficult for companies to become more circular. Most of them refer to interaction between actors in the industry. You talked about the limitations in the industry in regard to the current communication. This issue is highly connected to the possibility of attaining circularity in any project, as the connection between the different actors is vital to the implementation of circular economy.

3. What is your current strategy for overcoming this issue?

What we try to do, if you look at the industry, you can say that there are a lot of companies that are made by a one-man company, it is extremely difficult to see the development from their side. When you deal with very small companies you to tell them exactly what to do, medium-sized companies, large contractors we are 5 super large, the 20 or so are larger contractors that are still smaller than us but still big, and so on. So, a lot of the development has to come from the top in collaboration with engineers, architects and clients. What we are doing is, whenever we do a project (we try project from project), to actually convince the client to make a kind of integrated Project Delivery (IPD) which enables the contractors, architects, engineers and clients, maybe sometimes manufacturers, then we will discuss how we will optimise this project, this is different from what you usually do. We bring them to the room and try to optimise a project when we have found the optimal project we go apart and decide who does what. The way to operate

this new scheme is to bring everybody to a room, select your partners first, then put in the requests form the client, challenge them for optimisation, suggest recommendations. A number of clients will look a lot to cost/benefit for the next 5-10 years, but buildings last more. So look at the building on a longer-term, if you do the NPV calculation, you see that buildings will increase in values, they are assets, if you build it in a way to transform it and re-use the materials, you make a much better business case, and a lot of more clients are starting to realise this.

Would communication tools be able to ease the communication issues in the industry, or do you believe that a more deep-rooted solution is necessary? (you mentioned earlier communication, but this is currently hard)

There are a couple of them you can use, standards, I love standards, its a love-hate relationship. We have to have standards, and we have to develop them. Because it helps to refer the clients to different kinds of standards, that advances the industry much faster than any other thing.

The use of the same digital models, collaboration on digital models allows to see the economic and time impact of a change, and the rooms and all set-off values, we can load a large amount of information and use these tools on more than one parameter. In a lot more ways that you could 10 years ago. You can get any result; it depends on what the conditions are.

Traditional thinking slows down even the recognising of big changes in society, results have to match the society needs. You need the right parameters into consideration in order to design and plan. Change is happening, we are progressing.

You also discussed the low profit margin for many of the actors in the industry. This limits their ability to innovate and take chances on new methods and take on risk.

Would monetary incentives be sufficient to push the industry towards innovation?

What else could possibly help?

Yes. I think that what will happen, is that when you look at the return on capital investment, the low-profit margin is a problem, you don't generate enough margin to use 5% on innovation and development, we can't even use 5%, maybe we use 1-2%. The way we go about this is to get the clients on board, and have incremental innovation on new projects, and carry that innovation form one project to another (the customer pays for it), you do a few things you can control, so its incremental innovations. Innovation comes from a small project such as the circular house. So, there is no doubt about that higher margins would help.

We also talked about, last time, that the development in the industry is very dependent on the client. But, as you said: "Clients are focused too narrowly, on

what they need now. They have to be convinced that their needs will change. The company tries to broaden the perspective by nudging and talking about trends and experience, help make the customer understand that a building has to be looked at long term. And that you try and challenge them on their needs up front."

4. How are you currently trying to influence the clients to apply these perspectives?

For public clients often use and operate much too low to do the right thing. It is much better to spend more in the beginning to build more resilient buildings.

We work with a lot of things, I was at a seminar, or conferences or meetings. So, we want to collaborate and spread knowledge and have the possibility to influence a part of the world that grows faster than our current market. Bring in capacitors from all over the world and get new ideas, so we use conferences for spreading knowledge and influencing, and take in new knowledge which we use to inspire your clients. Both in our industry and other industries.

As well as working on these subjects with universities and student projects to get these ideas out there. The next generation will be the one that pushes this agenda. So, education is key. Promoting the new normal. Fuel the agenda in order to expedite this development.

Also getting new clients through this reputation of us going to conferences, which are a new market and more influence, it is an advantage to be known for having some innovative ideas.

What would you suggest to other contractors to tackle this contact points problem?

What do you think are some of the consequences of implementing this solution? I think that we are actually the client, for all of our subcontractors. In a legal matter, we are the client when it comes to this, we assume that position, so in a way, if you are a specialist in an area, when you bring new solutions to us, that will enable to test these solutions for this customer, you will enhance me to tweak my value proposition, that makes the client happy. This makes your position better to us in order to develop new contracts for different projects. A specialist can instruct several companies in an area, and how they could develop and promote more solutions of their own. We are only as good as our value chain behind us, we need to get it moving.

Money to build and money to maintain buildings are often (for public clients) part of two different accounts.

Do you find this to be a challenge presented to you when trying to influence a more long-term view on the client?

It is a huge challenge, and it's something that we have worked with quite a long time, we are making it better very very slowly. But the ball is rolling, and we push them to be better. And it is very short-sighted. Something is happening now; I think we will see development there.

Do you have any approach to still convince the client to invest in quality?

Yeah, I think a lot can be done. There is a right for better conditions of living, our industry should probably get on the front of this, and therefore save a lot of money in the healthcare industry. We have to bring this principle to the construction industry to a new level, but that goes back to the profit margin again. We need to promote that buildings are forming your life. IN the sustainability and circular economy looks a lot more into the building environment that we actually need, we can change people's mindset and behaviour.

Additionally, with your size and reputation, you have the opportunities to innovate and push the project frames. This partially comes in the form of you having the trust of reoccurring clients.

Do you think development in the projects (innovation, circular economy) can be achieved without the connection with the client?

Of course, we can always develop new solutions, but again, if I were to send you this, so it is more enduring than the original, in order to do that transaction, we need to establish some kind of relationship first. You have to create a relationship and trust with clients, after that you can present new options if there is no relationship the only option is to offer it cheaper than the market.

5. In the realm of expanding the industry, which possibilities do you see in using PPP contracts, in regard to implementing circular economy?

I think PPP is one of the models we can use, it takes into consideration the operations, but it does not take into consideration circular economy, or what the intrinsic value of the building's material. The number of buildings built with PPP is schools. The long-term view of schools has to be considered depending on the area. The development of the context where the building is built, the design should change. Design for disassembly would come in handy here. We need to add some kind of extra clause to PPP in order to support circular economies.

We build higher quality because we have to think about durability, buildings have a long-life cycle.

Design for disassembly is very feasible, it's one of the best models out there. If the life cycle expectation is longer than the usual due to location, durability and flexibility are to be considered more than disassembly. If you are in the outskirts, and you need a building for 30 or so years, I would use prefabricated modules, and the only thing that would remain, we the demolished foundations.

B.7 Scandi Byg Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

We have also assessed that according to our metrics you are one of the leaders in circularity practices according to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You are leaning towards the pillars Optimise, , and Systems Thinking because of your processes, reuse of materials / products and complete project processes.

As stated previously, we found that your company has a unique business model/stance in that you, mostly, do turnkey contracts, giving you a lot of control over the process, especially considering that you are also your own supplier, which helps you have a unique approach toward projects and the ability to control the processes.

1. What were the main motivators for adopting this business model? Did you start as a manufacturer or as a turnkey contractor?

When the company started it was building non-permanent, temporary, structures in the factories and then putting them on a truck and driving them out into the Danish country. Such things as ice cream shops etc.

Then it expanded to refugee camps in Africa

It accelerated around 2007-2008 when it was recognised that it was a relatively cheap product. And the potential of the process was recognised as well.

%So the development and growth of the business model was slow and it became bigger and bigger structures and more and more permanent structures, until they look like today.

The biggest challenge has been to convince the other actors, architects, 'byggeskadefonden', etc. that it was a good way of building.

%this is similar to the process CE must go through

They went from the challenge of it not being recognised as a 'valid' / 'proper' process, to being the proof of quality to others.

The sustainability aspect of the company has been very beneficial because they have been ahead of the game from the beginning.

If you are not competitive on the price in the market, then you are not representative, the fact that they are ahead on the sustainability as well as the price is what makes them competitive now.

Do you plan on expanding this business into another area?

They are just about to start developing their next strategy period. In this the focus

will be on innovation and sustainability. They will be the foundation in the next vision for the company.

They want to be in front in the industry in regards to sustainability and construction processes.

Why did you decide to expand your business like this?

Hurdles in the industry and company in regards to implementing Circular Economy.

You talked about the limitations in working with modules, because of the difficulties these pose in meeting specific design demands etc. This type of issue is relatable to attaining circularity (diversification, circularity pillar) in any project, as here, the choice of materials and processes are limited, therefore:

What is your current strategy for overcoming this issue? As mentioned, one of the biggest challenges they faced earlier in the company is the

need to prove that the processes and the model that they have worked. Therefore, they have spent a lot of resources in earlier days on going out and influencing the clients.

Nowadays there are more tenders where the focus is already on modular thinking from the beginning, which of course makes it a lot easier for the company.

These clients are also approaching the company increasingly, asking them how their model can be used to build what they want and for how much. Giving the company an edge as they have a quality, sustainable, well prices product.

But they are still good at going out to the bigger clients and presenting their products and the possibilities. Marketing themselves. It's about continuing to develop the network and branching out.

You mentioned that the list of architects who are working alongside you with this is expanding

Through tender, (turnkey) the company is partnering with a known architect, usually.

When a client approaches them, he usually brings an architect, this one will have to learn the product and design ways, thereby the list is expanded through the client.

What are you doing to achieve this?

Its harder for a 'normal' contractor, who takes on main contracts to have any kind of influence on the client and project choices. It depends on the contract type. You should get more value for the money when using the turnkey model.

Generally, according to the studies and the conducted interviews, we can say that there are a lot of problematic contact points, between actors, within the

industry. These contact points make it more difficult for companies to become more circular. Most of them refer to interaction between actors in the industry. In your case, the number of contact points has been reduced and you mostly deal with clients.

3.Is this model what allows you to be circular, or could your circularity be achieved if you were acting as only the manufacturer or contractor?

Yes, it could, but it would have some different administrative requirements for the company. There would have to be spend more resources on managing the process. There are many advantages to the model that they have in the company: there is a lot of knowhow.

There will be larger managing costs, more communication is needed, some sharply defined project, contracts etc. This is all very important.

What would you suggest to other contractors to tackle this contact points problem?

If to achieve a model like theirs, the contractor must be super sharp on their processes and demands to the project and ensure that the design and production both fits in with their model. With the use of partnering in some for between the different involved actors.

The standardisation of the company's product is a great advantage to them.

What do you think are some of the consequences of implementing this solution? Cost / resources, see above

As the clients are your main contact point, and you need to establish the idea of using modules in the design already before you are involved in the project (in the brief design).

4. How are you currently trying to influence the clients to create modular brief designs?

See above Svanemærket helps. Demands from the new clients to sustainability

Is this efficient?

The time they spend previously in the company history has created a place for them where it is now efficient, because they do not have to convince people from scratch to trust the process / product.

IN REGARDS TO CIRCULAR ECONOMY: Do you think that the way we now have to convince the client to build circular is similar, and should be done in the

same way, as what you have done to spread the modular building? The clients are already pushing.

Do you consider the fact that you have power to influence the client for future projects through the development of current projects?

5. In the realm of expanding the business, have you tendered for, or considered to tender for PPP projects?Have you analysed the possibilities?Why would it work/not work for you?Doesn't think that the company is big enough for this yet.

In regards to the circularity aspects mentioned in the beginning of the interview, two pillars remain as possible future focus areas for the company: Renewability and Diversification. Renewability refers to the source of the energy that you use, for example electricity might come from wind turbines. And diversification is strengthening the business in face of change (if the architects you have business with go out of business). Have you considered alternatives such as these? Do you see any future opportunities to go into these areas?

B.8 ALABU Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

We found that your company has a unique business model/stance, where you, act as admins but your board is made of residents, which offers a democratic decision board, which places you close to the end user and this allows you to have a direct influence on their decision, which helps you have a unique approach toward projects.

According to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You have special strengths in the pillars Optimise in effect of the fact that you have developed a model to cut down costs and take into account the end user, where you strive to provide affordable housing and thus you have the potential to connect the end user needs with the project itself (Systems Thinking), but have some drawbacks due to constraints due to the nature of the business (public and tenders).

As stated previously, we found that your company has a unique business model/stance in that you, have integration with the client, as well as managing the construction process through main contracts in order to have more control over the processes.

What would be the main motivational factors that would push you towards circular economy?

- Profit
- Flexibility
- Reputation
- Resource optimisation
- Circular processes are also cutting out resources

The most important thing is to ensure that the materials used and the processes, are safe for the company, because they have the user boards who are actually making the top decisions. This means that they have to spend the money on things which are ensured to be good investments.

It should be supported by the policies.

If there are any additions to the operations costs it's directly affects the renters, therefor they are careful.
Do you plan on expanding the business into any of these areas?

As you are trying to diversify yourselves through the development of sustainable housing

Do you feel a pressure to push the circularity into the company?

They want to support it. They try and go for the low hanging fruit. Just because they feel that they cannot focus on the bigger changes before there is more security. They do see the potential for supplying demolished material into the circle. They are not ready to take materials out of the cycle yet though.

(have you considered presenting circular economy as more of an optimisation and reuse of processes, resources and information, rather than the environmental side?)

According to others, there is an increase in the requests for sustainability certifications from the public clients in the industry at the moment.

Does this affect you?

Do you feel a pressure from your end users?

There is an increased focus on things such as DGNB certifications. They want to use these as well as they feel it creates an increased focus on the processes in the project. And thereby get some more quality and support the environment.

As you facilitate your own buildings you gain knowledge about where higher levels of quality is needed and beneficial to be implemented in the construction.

2. How do you, as a company, ensure the information of these things, from the operation, reach the right people in the preliminary design process.

Do you have any set processes for documenting, or sharing this information. (Feedback loops)

No real processes. They have the user boards, and these are the people using the buildings, their feedback in the boards is what they heard in the company.

They try to share among each other in the everyday processes. They try to share knowledge.

Have you thought of circularity as a way to reduce resource (money and time) waste, as well as a tool for optimising your business, while creating a solid potential base for future projects to come that might ask for this consideration? As we discussed last time, the company is part of NBE, which should help you achieve new knowledge and to be enriched with new possibilities.

Are you seeing these benefits in the company?

Are you seeing these benefits in the company?

Yes. There is an increased focus. They see some processes and are a part of some dialog, which they can learn from. Without actually doing anything themselves yet.

There are having more dialog with other entities, including the public. They do see the benefits.

Does it help with convincing clients when suggestions come from here? How is the information gained through this network spread throughout the company? And to the users?

Has knowledge from here led to any implementation in projects or in the company?

You talked about the limitations in decision making and taking risks due to your constraints, because of the nature of your company's market (public which must adhere to public tendering and answering to Byggeskadefonden).

A hindrance for you, as a company, in implementing Circular Economy, is that you, as mentioned answer to Byggeskadefonden. This means that it is difficult for you to implement new, experimental, and, thereby, circular products into your projects. "The problem lies in the use of reused materials because of the lack of CE markings etc."

3. What can be done to improve the ability to implement recycled material for companies such as yours?

Should this come from the manufacturers, or suppliers, themselves or from the governmental push to certify materials?

The government must find a structure where certifications of the materials can be achieved. And some processes can be started.

The last part of the process. Getting it certified. Is the hard part. The manufacturers need a way to know that the resources spend on handling the materials is also beneficial.

An easy frame to follow is needed. Something like the a,b, systems on fridges, which indicates HOW circular a product is.

Why?

As you mentioned, you are limited by some frameworks which a private client would not be limited by: This can limit the ability to construct buildings that are 1. Sustainable and 2. Easy to maintain.

This also means that they are going to be affected by the instatement of regulations in regards to circular economy by the government.

Will this create opportunities or challenges for the company?

It will mean that there will be creates some goals and some pressure. The fact that there will be pressure overall will make more manufactures etc, focus more on it. This means that there will be created more opportunities and ways to be circular. In the concern that maybe they will, as public clients, be covered by more regulations than non-public, he sees some challenges. And they would probably start by looking into the safer things, such as crushing concrete in order to meet any quota that is placed on them.

And that you choose main contracts in your processes to cut down on maximising costs by other parties, in order to achieve affordable building. When developing contracts:

4. What do you do to ensure the information is transferred adequately, the processes are optimal, you maintain quality, design and materials used live up to your standard?

Standards are difficult considering the nature of construction where every project is different.

They try and develop some standardised processes. If a project t looks like something specific, these people have to be involved.

In the total contract, the contractor can optimise their own profit on the cost of the client.

We talked to another client, who has the opposite approach and tries to mainly work with turnkey, because they can cut down on the conflicts between parties and therefore achieving faster project completion times, as well as less time to be dedicated to each single project. This client found that, overall resources are better spend focusing on the development of precise contracts and upfront dialog. And as you mentioned last you think it is necessary to "Be more precise in the development of contracts, do not be too vague, be critical of the material suggestions. As a client they have to be sharp."

5. You also mentioned that one of the main problems in the industry is that the agreements and contracts can be improved because they have some downfalls. How do you try and combat this?

As discussed last time, you consider that you could be part of the circular model as a company providing input to the cycle:

6. Are you doing anything to prepare for these possibilities?

They are using the NBE network to talk about it. But they are missing the system in which it will work. Considering the volumes we are talking about, there is significant logistics to consider. They are missing the way it can be done.

Have you considered design for disassembly or buildings as material banks?

Have you analysed the possibilities?

They have not really considered it, they do not think they can go in front.

Why would it work/not work for you?

This can offer you more flexibility with the future projects and can also help you hedge risk.

But you are not ready to take materials in and reuse yet "because of their responsibilities to deliver for the residents of the buildings.":

What are your main concerns in regards to this?

- The durability of materials
- Maintenance
- Life span
- Quality

All of these, cost of maintenance, risk

B.9 Søren Enggaard Interview 2 Summary

On the first round we conducted interviews with several companies within the industry and analysed the data we received. Therefore, we were able to asses where the industry, as a whole, stands in circularity practices and potential (from our sample's perspective).

According to the 5 circularity pillars: Optimise (resources), Renewability (sources of energy), Systems Thinking (holistic approach), Recycle (recycle/upcycling), and Diversification (for resilience). You have special strengths in the pillars Optimise in effect of the fact that you have developed a model to cut down costs and take into account the end user, where you are able to develop collaborations and projects with others in the industry (because they are private), not only based on tender, but also based on previous experiences and previous good collaboration partners, as we talked about last time, this enables you to control the processes and value chain.

Last time we talked about circular economy, you said: We must work more and more with sustainability (and CE) as a company and as an industry. The world is running out of resources, and that makes this focus necessary.

As stated previously, we found that your company has a unique business model/stance in that you, have a lot of control over the process, as you have all the decision power.

1. What would be the main motivational factors that would push you towards circular economy?

- Profit
- Flexibility
- Reputation
- Resource optimisation
- Circular processes are also cutting out resources

Circular processes are also cutting out resources

Profit is the main thing

A political pressure

They do have focus on the ability to changing the building in the future. Even as sometimes it's a small extra expense in the current moment, but a win for the future, when, maybe there are new renters. This includes making light walls so spaces can be changed and preparing installations to be changed slightly in the future. Do you plan on expanding the business into any of these areas? In the realm of expanding the business,

2. Have you considered design for disassembly or buildings as material banks? They have not heard of it.

Interested, but concerned with the costs which are connected with implementing it.

You talked about the limitations in working with other actors, because of the focus on personal profit in the companies in the industry. And that you have cut out some conflicts in your processes by using the turnkey contracts. We talked to another client, who has the opposite approach and tries to mainly work with main contracts, because they have more power over the design, quality, and materials in the projects. You use turnkey contracts;

3. What do you do to ensure the quality, design and materials used live up to your standard (you mentioned last time that you have developed knowledge of which materials should always be of higher quality fx which doors)?

You also mentioned that one of the main problems in the industry is that the agreements and contracts are too vague. How do you try and combat this?

They combat conflicts by spending a lot of time in the beginning. They have a lot of meetings where all the parties are talking to one another and agreeing, the physical meeting helps them build trust and makes it hard for people to try and cheat each other.

They also listen to their advisors (architects), in order to create better buildings which are easier to rent out in the beginning.

It's definitely a benefit to have the dialog in the beginning. This way everyone involved is able to voice their concerns.

They follow ABT and this is very helpful

The don't usually have to pull out the contract, because the dialog and repeated collaborations with the same actors, creates a better foundation.

When you're a public client you do not have the ability to choose who you want to work with.

The dialog in the beginning is extra important, so that the dialog is the foundation. Leaving the risk to the turnkey contractor is a good opertunity. The more dialog, the less risk for the contractor, the lower price.

There is an increase in the requests for sustainability certifications from the public clients in the industry at the moment. Does this affect you?

Do you feel a pressure from your end users?

Few have mentioned it. But they try and have a dialog, to determine what they are trying to achieve by certification.

As we just talked about, you mentioned last time that the company learns from the existing and previous projects about where in the construction of the project it is beneficial to invest in higher quality materials. This information is gained from managing the building which have already been built and trying to optimise the operation of these.

4. How do you, as a company, ensure the information of these things reach the right people in the preliminary design process.

Do you have any set processes for documenting, or sharing this information. (Feedback loops)

They have no processes as such, nothing is written down. This is because the company is so small so they just talk to each other.

Have you thought of circularity as a way to reduce resource (money and time) waste, as well as a tool for optimising your business, while creating a solid potential base for future projects to come that might ask for this consideration? The maintenance and operation of the building overtime costs much more ultimately than the construction. Therefore, this should be considered. – one problem is that this is not considered now.

B.10 Recordings of Round 2 Interviews

See attached folder B.10.

B.11 Lendager Assessment

					VINICAL VINICAL			
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Feels that the contractors and engineers are holding back the innovation, sustainability and circularity in the industry	1	Profit, Processes	2	2	1	0	0
	Limited influence in turnkey projects as the contractor chooses the system early in the process	1	Contract form, Linear, Tender	1	3	2	1	0
	Contractor is always focused on money	1	Contract, Tender, Profit	1	3	3		0
	Restrained by technology or costs	1	Profit	2	2	2	0	0
	The other players focus on building but not reducing material use	2	Linear	1	1	0	1	0
Lendager	Limited by the nature of the project, if it is sustainable it is not taken on	2	Collaboration Willingness, Partnerships, Possibilities of Project	0	2	u	0	0
	The industry is very conservative	2	Linear, Tender, Contract, Processes	2	4	2	1	0
	Feedback meetings but no format or document	2	linear. Processes	2	2	0	1	0
	In new partnerships other companies collaborate but it is hard to align concepts and approaches.	2	Partnerships, Contracts	0	2	2	0	0
	Regulations are a problem, specially due to their traditional ways, times have changed but not the regulations	2	Tender, Linear, Contract form	1	3	2	1	0
	Client knowledge and stance	2	Client's choice, Customer Satisfaction	1	1	1	0	0
	The construction industry has a very high level of risk	2	Distrust	1	1	1	0	0
				14	26	19	5	0

B.12 LINK Arkitektur Assessment

					P	LLAF	S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
LINK	When winning through competition, the design has to fit the brief, pushing other aspects will add costs and aspects which were not required. It could cause them to lose.	1	Contracts Form, Partnerships, Quality, Sustainability	2	3	3	2	0
LINK	The experience of the company is driving the decisions (the clients trust in the architects' knowledge and experience of what creates a better building (better flow, usespace etc.	1	Reputation	0	0	1	0	0
				2	3	4	2	0

B.13 NIRAS Assessment

					P	LLAF	S	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Projects need to be profitable and	1	Possibilities of					
	learning experiences	1	projects	0	0	1	0	0
	Tendering format for some	1	Tendering					
	projects	-	rendering	0	1	1	0	0
	Fixed price contracts limit the		Linear, Contracs,					
	amount of time that can be spent	1	Collaboration					
	on a client (changes require	-	Possibilities,					
COMPANY	money)		Profit	2	3	2	1	0
	Economy and profit are an issue	1	Linear, Profits	2	2	1	1	0
	Customers dont look at running							
	costs, its just about building	1	Brofit Lincar					
	something that is not so	1	FIOIIL, LINEAI					
	expensive and selling it			2	2	1	1	0
	Open tenders offer more conflict	1	Tender, Linear,					
	Open tenders offer more connict	1	Contract	1	3	2	1	0
	Distrust and companies just		Distrust, Profit,					
	considering themselves and	1	Contract					
	getting what they want		contract	1	2	2	0	0
	Price driven industry makes it		Tender					
	hard to work in and create	1	Contracts Linear					
	innovation, a small mistake can	-	Profit					
	cut your profit margin		Tione	2	4	3	1	0
NIRAS	Price driven industry is an issue	1	Linear, Tender,	2	2	2	1	0
	Clients mostly look at surront		Profit	2		2	-	0
	costs and rupping costs not	t						
	costs and running costs, not							
	focus at the memory Deeple	2	Profit, Linear					
	mostly consider the costs that							
	those will have (not in ganaral)			~				_
				2	2	1	1	0
	clients dont really know what	2	Profit, Linear	2	2	1	1	0
	they need			2	2	1	1	0
	Re-design from architects means	2	Dialog, Processes	2	2	1	0	0
	Low profits do not invito risk			2	2	1	0	0
	taking	2	Profit, Linear	2	2	1	1	0
	Long life sucles stifle speed of			2	2	1	1	0
	innovation (movies look into							
	nnovation (maybe look into	2	Dresses					
	processes and now to use or	2	Processes					
	combine materials instead of							
	using new ones)		D. (1) 11	1	1	0	0	0
	PPP only considers 20 years	2	Profit, Linear	2	2	1	1	0
	(base themselves on qualitative							
	solutions rather than quantitative,							
ı	meaning that it comes from past	2	Dialog, Expertise					
	experiences that are not							
	necessarily well kept)			2	1	2	0	0
				25	32	22	10	0

B.14 Dansk Boligbyg Assessment

					PILLAI O ST D 2 3 2 0 1 2 1 0 0 0 3 3 1 0 0 1 1 1 1 1 1 1 2 1 2 3 2 0 2 2 1 1 1 2 3 2 1 1 2 1 1 2 1 1 1 2 3 2 1 0 0 2 2 1 2 2 1 2 2 1 2 3 2		PILLARS		
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С	
	Everything is about economy	1	Profit, Linear, Tender	2	3	2	1	0	
	Need to maintain good relations (they currently can but spend a lot of resources)	1	Good relations, Partnership	0	1	2	0	0	
	Bureaucracy in dealing with big corporate clients	1	Public entities are slow	1	0	0	0	0	
	Entry point (time) for actors	1	Tender, Contracts, Collaboration possibilities	0	3	3	0	0	
	Public entities are slow, you need patience	1	Public entities are slow	1	0	0	0	0	
	If the money is not connected nothing will change	1	Profit	1	1	1	0	0	
	Connection between architects being able to draw nice things, and drawing nice things on a budget	1	Distrust, Competences	1	2	1	0	0	
	Municipalities are part of the problem in putting pressure with the economy	1	Linear, Tender, Profit	2	3	2	1	0	
	Amount of money spent during the processes	1	Tender, Contract Form	0	2	2	0	0	
	Industry has no morals	1	Distrust, Trustwothiness	1	1	2	0	0	
	They recycle concrete because it is cheaper than disposing of it	1	Value creation	1	0	0	0	0	
Dansk BoliByg	Too much risk in circular economy (materials they use)	1	Profit, Linear	2	2	1	1	0	
	The most expensive thing in the industry is the salaries	1	Profit, Processes	2	2	1	0	0	
	The industry is very conservative	2	Linear, Tender, Contract, Processes	2	3	2	1	0	
ע ני גי גי גי גי גי גי גי גי גי גי גי גי גי	Companies are unwilling to experiment, and with the use of untested material the contractor is too much at risk (byproduct of conservatism and pressure on money).	2	Profit, Processes	2	2	1	0	0	
	An incentive for collabs would be reputation	2	Reputation, Trustworthiness	0	0	2	0	0	
	Conformists (if delivered more to the industry, they just complain why price was not lower)	2	Client gains, Value creation	2	0	0	0	0	

B.14. Dansk Boligbyg Assessment

			1	2	1 24	0	0
Too many systems, they use 8 or 9 portals and tender formats, (standardisation would be good, but he thinks it wouldn't)	2	processes, tender					
the reuse of processes is a safety factor for the company because they have confirmation that it works	2	linear. Processes	2	2	0	1	0
Human factor (one pm compared to other pm) we work with humans	2	Good relations	0	0	1	0	0

B.15 Enemærke & Petersen Assessment

					Р	ILLAF	RS	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Limited on their selection of projects because of how the market is.	1	Possibilities of projects	0	0	1	0	0
COMPANY Enemærke og Petersen	They would like to be involved as early as possible including plot purchasing	1	Processes, Contract Form	1	2	1	0	0
	highly divided value chain, too much bureaucracy, displacement of responsibility. All creates distrust in the industry. (no other industry where everyone is this willing to screw each other over).	1	Contract, Linear, Profit, Tender	2	4	3	1	0
	Industry is behind in a lot of areas, specially in the work environment. If you benchmark compared to others, we are still very behind	1	Distrust	1	1	1	0	0
	Working in different offices (i cant imagine that anybody wants to work like this). we should meet and understand each other's business models and create solutions.	1	Collaboration, Partnerships, Dialog	1	2	2	0	0
	Official structures to enable collaborations and trust based work should be a part of the industry	1	Processes	1	1	0	0	0
Enemærke og Petersen	People who don't collaborate, black and white people, there are a lot of them in the industry.	2	Collaboration	0	1	1	0	0
	One risk is joining a partnership, and something political happens, and you have to make a rapid change because you have one big customer.	2	Linear, Partnerships	1	2	1	1	0
	can see there are not a lot of PPP projects, they might run 1 project a year. It is not a huge market, I find it much more interesting in an international point of view, as it turns into portfolio management.	2	Profit, Contract	1	2	2	0	0

B.15. Enemærke & Petersen Assessment

The whole idea would be to renovate or build new buildings, and actually offer the people who are going to maintain it, but the industry is not set up like this.	2	Linear, Contract	1	2	1	1	0
We would like to have as much possibility to come in as early as possible	2	Contract Form	0	1	1	0	0
It is a symbol of something, it is a start, we can not just sit and point to others. We need to do something. It has been the same argument for a hundred years	2	Distrust	1	1	1	0	0
			10	19	15	3	0

B.16 MT Højgaard Assessment

					Р	ILLAF	RS	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Clients are too narrowly focused on what they need now	1	Profit, Linear	2	2	1	1	0
	They work through tenders	1	Tender, Linear	1	2	1	1	0
	Without a mix of AB18 and ABT18 it is hard to pass on the information back and forth from contractors to clients	1	Dialog, Processes	2	2	1	0	0
	Constriction by contract types	1	Contract form, Linear, Processes	2	3	1	1	0
	Clients are not open to suggestions	1	Linear, Tender, Contract, Processes	2	4	2	1	0
	If there is a need to subcontract it may go to lowest price, but usually considers competencies and reputation (this is not great), and technical difficulty of task.	1	Profit	1	1	1	0	0
	You work with people not with companies	1	Good relations	0	0	1	0	0
	Trust and people defending their position is an issue, and the silo approach	1	Distrust, Dialog, Reputation	2	2	3	0	0
	Making things cheaper here and there is a problem when all solutions are put together, we dont necessary know where everyone cut costs.	1	Profit, Processes, Dialog	3	3	2	0	0
MTHeigaard	Communication is an issue, there is too much cost associated to the interfaces	1	Dilog,Contract	1	2	2	0	0
WIT Højgaaru	The safest approach is bullet first then cannons	2	Profit, Linear	2	2	1	1	0
	Industry division (5 really big contractors, 20 smaller ones and then smaller and smaller until one man company). Development has to be with the integration of engineers, architects and such. Teams working from different offices	2	Collaboration	0	1	1	0	0
	Clients look at cost/benefit from 5- 10 years, but buildings life cycles are longer	2	Profit, Linear	2	2	1	1	0

			33	41	26	12	0
PPP does not take CE into consideration (it only considers 20- 25 years)	2	Profit, Linear	2	2	1	1	0
Not enforcing the thought that buildings shape the way we live (health issues)	2	Profit, Linear, Value creation	3	2	1	1	0
Short-sighted ness	2	Profit, Linear	2	2	1	1	0
Subcontractors dont mention their innovative ideas to main contractors	2	Dialog, Collaboration Willingness	0	1	1	0	0
Public clients dont necessarily think about investing more at the moment to save in the future	2	Profit, Linear	2	2	1	1	0
Low profit margins are an issue	2	Profit, Linear	2	2	1	1	0
thinking, the developments do not meet the users needs	2	Contract, Processes	2	4	2	1	0
Traditional public industry		Linear Tender					

B.17 Scandi Byg Assessment

				PILLARS			RS	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Have to influence the client to use thier types of produccts	1	Competences	0	1	0	0	0
COMPANY	It has to be proven the methods work before others trust it	1	Linear, Tender, Contract, Processes	2	4	2	1	0
	Limited in who they can work with, because they have untraditional methods	1	Collaboration possibilities	0	1	1	0	0
	Industry is a hard environment, hard tones	1	Dialog	1	1	1	0	0
	The focus on maintaining good relations with clients can hurt relations to other contractors	1	Good relations, Distrust, Dialog	2	2	3	0	0
	The more relations you need, the more conflicts	1	Profit, Distrust, Processes	2	2	2	0	0
	The way the tender works sets limits for the collaborations. This is one of the main issues. Because of the fact that everything is about price	1	Tender, Collaboration, Profit	1	3	3	0	0
ScandiByg	The focus ends up being on the price of the construction rather than what is actually important for the operation of the building afterwards	1	Profit, Linear	2	2	1	1	0
ScandiByg	The biggest challenge has been to convince the other actors, architects, 'byggeskadefonden', etc. that it was a good way of building	2	Distrust, Processes	1	1	1	0	0
	If you are not competitive on the price in the market, then you are not representative	2	Profit	1	1	1	0	0
	Its harder for a 'normal' contractor, who takes on main contracts to have any kind of influence on the client and project choices. It depends on the contract type	2	Contract form, Linear	1	2	1	1	0
	For a normal contractor to reach circularity: There will be larger managing costs, more communication is needed, some sharply defined project, contracts etc.	2	Profit, Communication, Contract formulation, Tendering	1	3	3	0	0

B.18 ALABU Assessment

					PILLARS D ST D R 1 1 0 1 2 1 1 1 3 2 1 1 4 4 2 1 3 3 2 1 4 4 2 1 3 3 2 1			
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	Limited by contract form	1	Contract	0	1	1	0	0
	Tender for everything	1	Tendering, Linear	1	2	1	1	0
	Lack of guarantee on materials (for reuse), not CE marked, the dont know if they have the same performance, don't know what the maintenance requires, they answer to the byggeskadefonden	1	Distrust, Profit Linear	3	3	2	1	0
	Relationship between client and contractor because of the profit and quality (both try to maximize it)	1	Profit, Quality	1	1	1	0	0
ALABU	Avoids turnkey because they have less control, but this means they also need to put more time into each project	1	Tendering, Contract, Collaboration Willingness	0	3	3	0	0
	They would like the industry to improve in the precision of the developed contracts.	1	Contract formulation	0	1	1	0	0
	Quality and risk of reused material	2	Quality, Distrust	2	1	1	1	0
	No feedback loops, they have a user board	2	linear. Processes, Dialog	4	4	2	1	0
	Hard to implement recycled materials, government must find a structure for certification	2	Profit, Linear, Distrust	3	3	2	1	0
L S C T C T T C C	Limited framework will create some pressure to become more circular, or recycle more, which is hard if you can only have so many options, like crushing concrete	2	Profit, Linear	2	2	1	1	0
	There is no model for a circular company or business model that they can work with (so far), being part of the NBE	2	Processes	1	1	0	0	0
				17	22	15	6	0

B.19 Søren Enggaard Assessment

					P	ILLAF	RS	
COMPANY	PROBLEM	Interview	CATEGORY(ies)	0	ST	D	R	С
	The price is one factor	1	Profit	1	1	1	0	0
	The chemistry with the person	1	Good relations					
	involved in the project	1		0	0	1	0	0
	There are challenges in the		Tender Contract					
	collaboration in the industry	1	Collaboration					
	mostly connected to public tender	-	Profit					
	rules		Tione	1	4	4	0	0
	Many conflicts in the projects	1	Collaboration,					
	interprojects	1	Profit	1	2	2	0	0
	The agreements in the industry							
	are too vague. Because of this a		C					
	lot of conflicts are created	1	Contract					
	skeptical of the use of the		formulation					
	certifications etc			0	1	1	0	0
	Pressure must come from the							
	client to develop more		Client's choice,					
	sustainable, and certified	1	Customer					
	buildings		Satisfaction	1	1	1	0	0
	CE has to be economically							
Søren	beneficial for the company before	1	Profit					
Enggaard	it will be considered			1	1	1	0	0
LIIGGUUIU	It is made more difficult because							
	all projects are different,							
	therefore there is a bigger		D					
	learning curve to implementing	1	Processes,					
	Circular Economy in construction,		Realisability					
	than there is in some other							
	projects			2	1	1	0	0
	Does not know of design for							
	disasembly and material banks,	2	linear. Processes					
	lack of knowledge			2	2	0	1	0
	No processes for feedback and		linear Processes					
	information sharing	2	Dialog					
				2	2	0	1	0
	The maintenance and operation							
	of the building over time costs							
	much more ultimately than the							
	construction. Therefore this	2	Profit, Linear					
	should be considered. one							
	problem is that this is not							
	considered now			2	2	1	1	0
				13	17	13	3	0