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Consequences for the project manager when working with circular economy in the construction industry

Master's thesis in Design and Construction Project Management

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Abstract

The topic of circular economy (CE) and how to implement it have gained a lot of interest and focus in recent years, but a focus on how the project manager (PM) is affected by the implementation is missing. The aim of this study is to develop an understanding of how the PM role is affected by working with a CE focus, and to translate the existing project process into a process that enables circularity. Furthermore, the aim is to identify consequences for the project manager and identify gaps in the current project processes hindering CE. The research question to fulfill the aim is: What are the challenges to implement CE for the project manager at Lokalförvaltningen? This is analyzed through a case study of a school in Bräcke, following the processes and tasks of the PM, in combination with an interview and literature study to gather empirical material. The findings show that implementing a CE focus means that the PM must deviate from an established routine and new processes, The PM is measured on time, economy, and quality, and as projects are likely to be both more expensive and more time-consuming, it is important that the PM is given more guidance from their superiors. The PM needs to be more present in projects before a routine for working with CE is in place, as there will be a lot of uncertainty factors. Furthermore, collaboration between projects need to be in place to enable material exchanges. The conclusions presented are that the project process will become more complex when working with a CE focus, and additional demands will be put on the PM regarding planning. A coordinating role both within and between projects, working with CE topics and supporting the PM, is a recommended aid.

Keywords: Circular economy; Project management; Construction industry

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Anna Axell & Sara Engqvist, Gothenburg, June 2021.

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Dictionary and descriptions

Feasibility study	Förstudie
Project planning document	System handlingar
Ground /soil	Mark
Control, regulating and monitoring	Styr regler och övervakning (SRÖ)
Area specific experts	Sakkunnig
Technical requirements and instructions	Tekniska krav och anvisningar (TKA)
Kitchen	Storkök
Cost for change and additional work	ÄTA
CE marking	CE märkning
Lokalsekretariatet, Grundskoleförvaltningen	Municipal organizations that are part of the municipality of Gothenburg city.
City of Gothenburg	The term used in this thesis when discussing the municipality of Gothenburg city
Circular, circularity	The terms used in this thesis to describe a focus on CE
Byggvarubedömningen (BVB)	Organization the assesses construction-related products based on their chemical content, and environmental impact during the life cycle.

1 Introduction

This chapter presents an introduction, aim of this study, research questions and limitations.

Sweden is usually marketed as a country in the forefront regarding minimizing waste, recycling and energy recovery from waste (Sveriges avfallsportal, 2021). The situation within the construction industry shows a different image. In 2018 only about 52% of identified waste created in the construction and demolition industry was recycled (Boverket, 2021b), and about 40% of the toxic waste created in the country came from the construction industry (Svenska miljöinstitutet, 2021).

The same year the construction industry was responsible for 21% (11.8 million Tonnes) of Sweden's total greenhouse gas emissions (Boverket, 2021a). A number that only accounts for the emissions released within Sweden and excludes the emissions from imported goods, emissions of an additional 5,8 million Tonnes greenhouse gases globally.

Within the construction industry, the production and renovation phase stand for a large majority of the emissions (Boverket, 2021a). While the energy consumption in the using phase of a building's life cycle has reduced over the years, the emissions from the production and demolition phase have not changed significantly. The reasons are complex and connected both to emissions released in the material production as well as the energy usage within the actual construction of the building (Fossilfritt sverige, 2018).

Fossil Free Sweden is a national initiative of the Swedish Government with the goal that Sweden will be one of the first fossil free nations in the world (Fossilfritt sverige, 2018). To reduce the amounts of emissions the Swedish construction industry together with Fossil Free Sweden has developed a roadmap of how to reduce the amounts of emissions created down to zero in the year 2045 (Wärmark, 2020). A mission connected to the whole profit chain within the industry to change towards climate neutrality, one important action in this road map is the transition from linear to circular value chains (Fossilfritt sverige, 2018). Four key factors identified by the road map to reach zero emissions were: (Fossilfritt sverige, 2018):

- Collaboration, leadership and knowledge.
- A development from linear to circular processes.
- Public procurement as an engine for change.
- Long-term vision that enables investments and conversion to climate-neutral materials and processes.

The topic of circular economy (CE) and how to implement it have gained a lot of interest and attention in recent years, but a focus on how the project manager (PM) and the project organization are affected by the implementation is missing.

1.1 Aim

The aim of this study is to develop an understanding of how the project manager role at Lokalförvaltningen , a public client organization, is affected by working with a CE focus. As well as to translate and remodel the existing project process into a process that enables circularity. Furthermore, the aim is to identify the consequences for the project manager and to identify gaps in current project processes hindering CE.

1.2 Research question

The research question to fulfill the aim is: What are the challenges to implement CE for the project manager at LF? To further elaborate, three sub-questions has been chosen:

- What barriers and enablers regarding circular processes in the construction industry have been previously identified in the literature, and how would they affect the project manager and structure at Lokalförvaltingen?

- How Lokalförvaltningen is working currently and how that could be adapted to circular processes?

- How incorporating a circular focus could influence the work of the project manager?

1.3 Limitations

To be able to answer the research question, boundaries have been formulated for the thesis. To begin with the reference project is a school building, the thesis is therefore limited to the production of schools. As Lokalförvaltningen has a local Swedish focus, the thesis is only looking at the effect of the Swedish construction industry. As the thesis if focused on existing building and reuse, the part of CE connected to designing for adaptable buildings is excluded and the focus if limited to the two first steps in the waste hierarchy, recycling, recovery and disposal is not taken into account. Lastly, processes connected to logistics were decided not to be included in the reference project.

2 Background

This chapter presents the background to this study including a brief introduction to linear economy, an introduction to CE, and different CE definitions including Lokalförvaltingens definition of a circular construction and demolition process.

A linear economy is often described as take, make and dispose and the system does not include the end of life (Sariatli, 2017). One characteristic of linear economy is "the single-use" thinking and instead of creating new values at the end of life of a product, the product is dispose creating waste (Esposito & Soufani, 2018). The construction industry is known for using a linear economy model and the linear economy model affects the entire building's life cycle, from the early phases to end of life (Benachio et al., 2020).

2.1 Circular economy

In contrast to linear economy, CE is described in Figure 1, the butterfly diagram created by Ellen MacArthur Foundation (2019).

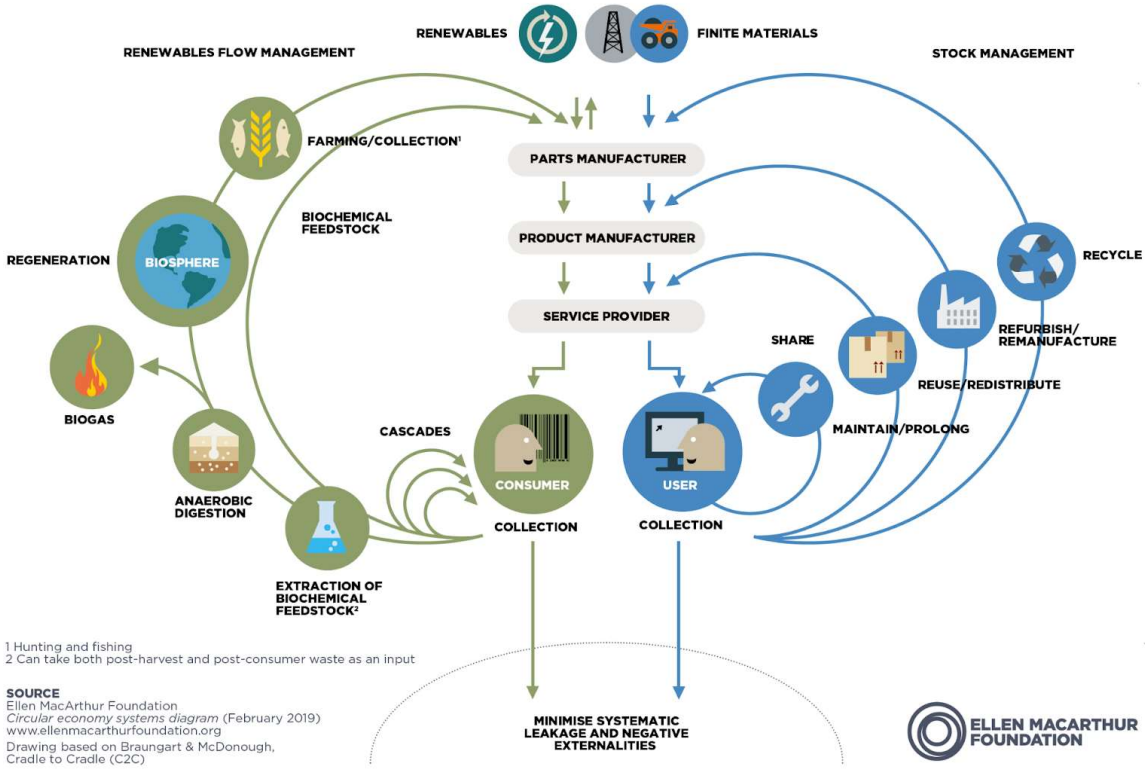

Figure 1-. Explanation of CE, the butterfly diagram describing technical and biological material through a value circle (Ellen MacArthur Foundation, 2019).

In Figure 1, the materials and processes are circulated, and the continuous flow describes CE by creating value chains though value circles (MacArthur Foundation, 2019).
CE in construction is expected to have a positive influence on sustainability, IVL has done the report were the reuse potential for Swedish office interiors is estimated to 25 000 Tonnes and the climate savings to 43 000 Tonnes carbon dioxide (Andersson et al., 2018). CE in the construction industry should contribute to a reduction of waste, reduce the need for virgin material and thereby reduce the CO2 emissions (Andersson et al., 2018). The contribution of CE is connected to the Sustainable Development Goals (SDG) illustrated in Figure 2.

Figure 2 - Visualizing the SGD 11, 12 ,13 (UN, 2015).

The reduce of carbon footprints is targeted in SDG 13, the reduce of virgin materials is a contribution to SDG 12 and the CE in the construction sector contributes to resource efficiency and reduced CO_2 emissions SDG 11 (UN, 2015; Fossilfritt sverige, 2018).

2.2 Definition of circular economy

Different forms of the CE concepts have been present throughout history, and no clear origin or who developed it to begin with is known (Kirchherr et al., 2017; Winans et al., 2017). As a result there is no universally accepted definition (Kirchherr et al., 2017; Prieto-Sandoval 2018). The concept has been used and adapted by different organizations and on varying business levels to aim and adapt the concept towards different goals and methods of reaching them. In an effort to conceptualize a general definition of CE Kirchherr et al. (2017) compared 114 articles containing CE definitions, out of these 95 different definitions were found. The most commonly recurring definition was provided by the Ellen MacArthur Foundation (2012) stating that:

"[CE is] an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."

An aim formulated by the city of Gothenburg, is to transition from a linear economy to a CE: *"To move from a society where we consume towards a society where we reuse. By taking better care of what we already have"* (Cirkulära göteborg , 2020).

To move towards CE, several additional subgoals are formulated: *"To find ways to design, produce and use our resources smarter, by making it easier to reuse, repair and share instead of buying new or discarding. To make it easy for the people in the city to reuse, share and repair their belongings. That the City of Gothenburg, together with business actors, should offer solutions that encourage sustainable consumption. As well as to stimulate external business actors to design and produce smarter products and services. And that the City of Gothenburg should set a good example by switching from a linear to a CE within its own administrations and companies. As well as focusing on reusing more and reducing construction and demolition waste when we renovate and build new"* (Cirkulära göteborg, 2020).

2.2.1 The definition of a circular construction and demolition process

Connecting the definition of CE to the construction industry, Lokalförvaltningen (LF) has formulated a definition of a circular construction and demolition process. Which will be further used in this thesis.

"In a circular construction and demolition process, existing resources are used to the greatest possible extent. Reused and recycled materials are to be the norm, and new virgin materials are the exception. [...] Products are designed so that they can be dismantled and then reused or recycled in many stages at a maintained value. In this way, buildings will in the future increasingly be seen as valuable material banks. Long service life and the opportunity to repair and adapt to changing needs are also prioritized. If supplementation needs to be done with new materials, waste is avoided as much as possible and what is still produced is taken care of for reuse or material recycling" (A. Karlsson, personal communication, February 24, 2021).

3 Method

This chapter presents the method and methodology approaches the authors have chosen to conduct in this study. Including the research approach, an interview study, a reference project, a literature study and finally a validation of the result and actions taken to maintain a high ethics.

3.1 Methodology

This thesis is written in a collaboration with LF and the two authors has contributed equally. The methodological approach of this thesis was a case study of the PM´s role and the project process.

3.2 Research approach

This study was performed with a qualitative approach, used to explore and understand the PMs' perspectives and external actors' perspective on CE to be able to get a better understanding (Denzin & Lincoln, 2005), this was done through semi-structured interviews presented below. A qualitative research strategy is better adapted to subjective research questions (Flick, 2014).

The research approach used in this thesis is an abductive research strategy. The approach allows a continuous development of the included theory, to facilitate new angles discovered during the forming of the thesis (Saunders et al., 2015). The abductive approach moves back and forth between an inductive and deductive research approach. Combining the ability to build a theoretical framework based on empirical data collected, with the ability to make assumptions from the framework. A way to draw conclusions from the theoretical framework and at the same time develop the theoretical framework further (Bell et al., 2019).

3.3 Literature study

The literature study was performed to identify and summarize barriers and enablers connected to CE. As well as to create the initial theoretical framework of the research. The findings were categorized under the headlines: Logistics, Building technology, Politics/legislation, Standards, Process, Engagement, Knowledge and Uncertainty economy and time. The barriers and enablers from the literature were summarized in short sentences, in an Excel-file, and categories were developed through themes found in the sentences. The headlines were chosen through the developed categories. The categorization was performed to identify areas of importance and to visualize the connection to the PM and the project process. The search engines Google scholar and Scopus were used to find literature, scientific articles and reports selected. A wide variety of keywords was used to identify literature from different angles. The most commonly used were: circular economy, construction industry, project management, circular construction, reuse material, and building with reuse. The literature with a multitude of citations were prioritized in the beginning to identify well known topics and established barriers and enablers. Newer and less cited literature were included later on to expand and validate the findings. Scientific articles available on the Gothenburg city, and LF website connected to CE were included, to gain a local, connected perspective.

Further, a continuous literature study was performed during the work with the thesis to develop a deeper theoretical knowledge and develop the theoretical framework. The literature were mainly reports and articles on a Swedish and Gothenburg level, as well as industry connected articles. FN, EU and Swedish political policies, campaigns and articles connected to waste management, CE and construction were also a part of the continuous literature study.

3.4 Reference project

A reference project was studied to get an insight in to LFs processes and the role of the project manager. For the reference project an instrumental case study method was chosen. A method where the case itself is not the main topic being researched, but a tool for researching an connected subject (Denzin & Lincoln, 2008). In this case the Bräcke school project was studied to gain understanding of the PMs role in the project. In an instrumental case, the case is thoroughly investigated, with the additional aim to gain a conclusive image of both the case and the main subject investigated (Denzin & Lincoln, 2008). The case selected can be both a special case, as well as a routine typical case, depending on the main aim of the research. The Bräcke school project was selected as a typical LF project, to portray routine processes. It was also chosen due to it being a combination of a renovation and a new production, as well as having a PM with an interest in the topic.

The reference project was initially researched by going through the Bräcke school project documentations at LF internal project platform Projectstyr. Documentations from the feasibility study, project goals and aims, the LF project process, as well as project roles were investigated. Further the website of LF and the city of Gothenburg were used to gain understanding and insight of LF as an organization, responsibilities and goals regarding CE in the municipality. At LFs website the LFs technical requirements and instructions (TKA) were investigated to gain a detailed understanding of requirements as well as notions of CE implementation, or conflicts. Performed to gain a deeper understanding of the focus at LF and areas of certain importance. An interview study was performed with the PM_BRÄCKE an LF supervisor, presented further down.

Non-participant observations of the project organization were performed on three occasions. The non-participant method can be used to observe behaviors without interfering with those being observed (Bell et al., 2019). The observations were unstructured observation, a method used to develop a wide understanding of routine behaviors, instead of observing a pre-selected observation schedule (Bell et al., 2019). A compiled list of the observations are presented in Table 1.

Table 1- Presenting the observations

Meeting type	**Theme**	**Participants**	**Duration**
Program phase meeting	HVAC and Damp concerns and solutions for the project	PM_Bräcke Area specific expert	60 min
Program phase meeting	Presenting the result of assessments	PM _Bräcke Area specific expert Ground/soil, and environmental consultants	60 min
Startup meeting for design team	Introduction of design phase and project information	PM _Bräcke Design manager Design team consultants	120 min

All observations were performed over Microsoft teams. The aim of the observations was to observe working methods, focuses and to get an insight into how topics are discussed and how participants communicate within the project organization. The unstructured observation method allowed new understandings to be developed according to what was found during the observations. The observations were used to develop knowledge and develop the theoretical

framework and prepare for the interviews with the PM, as well as gain information presented in the reference project.

3.5 Interview study

The semi-structured interview method was used in the interview studys with the external actors as well as in the reference project, a semi-structured interview meant that the respondents answered a prepared interview guide that allowed for a discussion and greater flexibility in the empiric study (Bryman, 2012). The interview guides are available in Appendix 1-7. All the interviews were recorded and transcribed. The transcription makes it possible to validate what was said in the interview (Bryman, 2012). The semi-structured interviews were done digitally through Microsoft Teams. The interviews were held in Swedish and the citations were directly translated to English. The interviewees were all sent the result and their included citations for acceptance before publishing.

The first interview study was performed to get a Swedish perspective on CE in the construction industry. The duration of these interviews was approximately 30 minutes. All participants were informed about the aim of the study and that their contribution would be anonymous. The respondent's selection was made through a CE conference for the construction sector. The reason for this was to find respondents with an interest in increasing circularity within the industry. One respondent that was contacted, did not respond and one of the respondents canceled the interview due to a lack of time. All other respondents contacted accepted. Furthermore, two of the respondents were contacted through recommendations from LF. In addition to the semi-structured interviews, two webinars were used to gather information from a client's organization and a management consultant. The reason for this was that webinars were matching the questions in the interview guide presented in Appendix 1. The findings from the interviews and webinars were categorized under the headlines; Processes, Economic and Uncertainties, Complexities, Knowledge, Engagement, Standards & Certification. The same categories were used as in the literature study with the addition of Complexities and Certification which were new findings. Some categories form the literature study were not mentioned by the respondents. The categorization was performed to enable comparison with the literature study and the reference case. A compiled list of the information of the external actors are presented in Table 2.

Table 2 - Presenting the respondents of the external interview study

RESPONDENT	ROLE IN THEIR ORGANIZATION	DATA COLLECTION	DURATION
CONTRACTOR 1	Sustainability Strategist	Interview	20 min
CONTRACTOR 2	Construction manager	Interview	30 min
ARCHITECT 1	Architect	Interview	30 min
CONSULTANT 1	Installation consultant	Interview	40 min
CONSULTANT 2	Structural engineer	Interview	30 min
CONSULTANT 3	Management consultant	Interview	40 min
CONSULTANT 4	Management consultant	Webinar	-
CLIENT 1	Sustainability Director	Webinar	-

A second interview study was performed with the representatives at LF. Two semi-structured interviews were held with the LF supervisor, one to develop our understanding of LF and their focus and work regarding CE, and one to further develop our understanding of the project process. The interviews were about 60 min presented in Table 3 - . A three-hour workshop was held with the LF supervisor, with the focus on the LF and Bräcke school project process, held at Chalmers, to develop a deeper understanding of the case. Continuous communications were held with the LF supervisor during the project by email and shorter informal digital meetings over teams. Four semi-structured interviews were held with the PM at Bräcke school. The aim of the interviews is presented in Table 3. The interviews were about 60 min.

Table 3 - Presenting the interviews study with the PM_Bräcke and the LF supervisor

RESPONDENT	ROLE AT LF	THEAM OF THE INTERVIEWS	DURATION
SUPERVISOR AT LF	Environmental engineer	LF and CE focus	60 min
SUPERVISOR AT LF	Environmental engineer	Project Processes	65 min
PM_BRÄCKE	Project manager	PMs role	65 min
PM_BRÄCKE	Project manager	Bräcke school	60 min
PM_BRÄCKE	Project manager	Selected topics	80 min
PM_BRÄCKE	Project manager	Follow-up	60 min

The findings collected from the initial part of the case study, the work with the LF supervisor as well as the observations were all used to formulate the description of the LF, the Bräcke school project and the PM role in the case study.

The third interview with the PM_Bräcke, presented in Chapter 8, were focused on three selected topics. The topics were identified and selected through the findings of the literature study, interviews study, and initial parts of the case study. The topics were considered essential for LF's future work towards the implementation of a circular focus. The selected topics were:

- Processes that are currently circular at LF connected to renovations projects.
- Collaboration between internal projects and PM´s to increase reuse material exchange.
- Material inventory as an enabler to identify the reuse of material in the renovation projects.

3.6 Validity and ethics

As presented the external actors were selected through a CE conference in order to gather respondents that had an interest in the subject. This could lead to biased information and may have had affected the result because resistance towards CE was not included. Furthermore, there was only one PM at LF that was participating in this study. This could also have affected the result since the PM_Bräcke had a positive attitude towards sustainability. The thesis was written during the covid- 19 pandemic and in a distant setting, limiting the spontaneous conversations and insight into LF and the Bräcke school project. Possibly affecting the result of the study as the work of LF was changed to a work from home setting.

This study was conducted according to Diener and Crandall (1978) four main categories of ethics:

- Whether there is harm to participants.
- Whether there is a lack of informed consent.
- Whether there is an invasion of privacy.
- Whether deception is involved.

The interviews were voluntary and no responders were forced to participate in the interviews. Before the interviews were conducted the respondents were informed about the aim and how the information would be used. All the respondents are anonymous in order to preserve the personal integrity of the participants. Further, the respondents were allowed to read and approve the usage of their reflections in the study. In the approval process, the participants could make changes, additions, or clarify possible misinterpretations from the interviews.

4 Theoretical framework

This chapter presents the result of the literature study. Barriers and enablers connected to the CE in the construction industry are presented. The barriers and enablers are categorized under the different headlines: Logistics, Building technology, Politics/legislation, Standards, Process, Engagement, Knowledge and Uncertainty economy and time.

4.1 Logistics

According to Minunno et al. (2018) and Danckwardt et al. (2019b) the logistics supply chain is not yet mature for the CE in construction (Minunno et al., 2018; Danckwardt et al., 2019b). The lack of supply of reused materials and inconsistent supply chain is mentioned as barriers connected to logistics (Hossain et al., 2020; Minunno et al., 2018). Researchers have underlined that there is an imbalance between demand and supply for reused material (Ghaffar et al., 2020). The dismantling material needs to be stored, and space limitation is mentioned as an obstacle during the construction process (Gorgolewski, 2008; Ghaffar et al., 2020).

One enabler mentioned, is to create a take back system for logistics, to enable a circular supply chain. The existing supply chain is described as a one-way street and to be able to create a circular supply chain the development of a two-way road and a reverse logistics infrastructure is needed (Adams et al., 2017; Hart et al., 2019). The development of a reversed logistics infrastructure should include materials marketplaces, material storage facilities and upcycling facilities that may solve and help with practical issues regarding logistics (Hart et al.,2019). The development of a second-hand market for materials, a high value secondary market is a possible enabler for the reuse of material (Adams et al., 2017). Nordby (2019) mentions an online marketplace for reuse of material to make it easily accessible.

4.2 Building technology

The entire process of dismantling buildings to retrieve material and components is a new focus connected to circular projects. The literature showed several barriers connected to fixings used in existing buildings, damaging material when disassembled (Minunno et al., 2018; Finch et al., 2021; Gorgolewski, 2008). The fact that most current buildings and building components were not designed to be disassembled were generally pointed out as a barrier in a study by Chini, and Bruening (2003). In addition to the problem with fixings, toxic and hazardous materials present in current buildings is an additional barrier for retrieving usable material when dismantling buildings (Minunno et al., 2018; Chini and Bruening, 2003; Finch et al., 2021).

Regarding building technology, the enabler of circularity presented in literature can be summarized under the headlines, design for circular usage of buildings and components, and actions to simplify deconstruction. Under design for circular usage enablers such as, promoting usage of modular components and prefabrication in the design process to enable easy relocation of entitle components in the future, as well as designing open building systems to create easy adaptable floor plans, can be mentioned (Flinch et al., 2021). Under simplify deconstruction, enablers connected to the fixings, recommending ones that are easily dismantled are presented, together with the advice against using hazardous materials, and promoting usage of durable components that are easy to handle for the workers on site (Flinch et al., 2021).

4.3 Politics/legislation

Construction practices, material usage and waste management are not only controlled by the internal project organization, it is also controlled by national as well as EU laws and regulations. In Sweden the policy instrument AMA, which regulates how we build in the industry, currently does not include circularity in its descriptions (Danckwardt et al., 2019a). Furthermore, a future barrier complicating working with a CE focus, is the fact that there is no generally accepted definition of circular construction, or CE (Finch et al., 2021; Kirchherr et al., 2017), and there is no globally accepted policy support for CE in place (Mahpour, 2018). Additionally, EU regulations demand certification for structural components which is a barrier according Ghaffar et al. (2020), and creates the additional step to perform in a circular project, reassessing the material (Ghaffar et al., 2020; Minunno et al., 2018; Hart et al., 2019). The process of getting material certified is also a barrier on its own (Andersson et al., 2019).

Some findings also point towards political measures to promote and enable CE. Examples such as creating laws that enforce the inclusion of reused materials in all new productions or other circular processes within projects (Ghaffar et al., 2020). Political support for public actors when using public procurement to increase CE is also recommended, as well as to reform the laws that currently obstruct circular construction (Hart et al., 2019). Other examples could be financial incentives from the government such as reduction in value-added tax (VAT) for CE projects, or developing new tax structure and fees that support business actors in the transition from a linear to circular system (Nordby, 2019; Hart et al., 2019).

4.4 Standards

In addition to laws and regulations, industry standards and guidelines seem to not yet be adapted to promote circular processes (Hossian et al., 2020). This includes technical manuals and environmental assessment tools, but also the procurement requirements and consultant assignments, working in opposition to circularity and making it difficult to change and innovate material and product flows (Danckwardt et al., 2019b). Hossian et al. (2020) mention that the focus of standards and resource policies is primarily targeted at the efficient use of materials and not on the reduction of the resources. Building codes and material standards are often not referred to in the context of reusing materials or building components, complicating the standardization of these parts (Chini & Bruening, 2003). Benachio (2020), mentions the lack of standard practice for reuse material as an obstacle in the adoption of the concept CE.

Client organizations usually have their internal standard which similarly to the industry standard can work against incorporating circularity (Danckwardt et al., 2019a). The TKA used at LF is highlighted by Danckwardt et al. (2019a) as it currently lacks a life cycle and reuse focus that might work against incorporating circularity. Danckwardt et al. (2019b) highlights a number of requirements that currently aren't being requested in standards that could aid in the transition towards circularity; The lack of governing directives regarding reuse of materials, and the lack of requirements regarding digital information storage and digitalization. The lack of standard solutions, create a habit of using unique solutions in projects, complicating reuse in future projects as material and components lack uniformity (Danckwardt et al., 2019b). An additional barrier connected to industry standards is the difficulty regarding warranties. Currently there is no system for warranties for reused materials, something that needs to be developed and widely accepted within the industry to enable reused materials (Danckwardt et al., 2019a). Industry wide acceptance of system boundaries for assessment tools for sustainability, such as LCA and LCC assessment also need to be in place (Danckwardt et al., 2019a). As well as common requirements and understanding of the process of material

inventories, needed to locate materials in buildings (Danckwardt et al., 2019a), to clarify what should be measured and to make sure comparisons are made on equal terms within the industry.

References to industry standards in current projects are usually made in an unspecified way (Danckwardt et al., 2019b). Forcing actors to stay within the boundaries of the entire standard, something that might not always be necessary for the clients requirements. The unspecified requirements could hinder innovation in areas where the standard isn't as important for the client (Danckwardt et al., 2019b). The same goes for requesting specified materials instead of functions, reducing the options for the contractor and complicating the process of sourcing materials. Standard solutions and measurements could both be an enabler for future reuse, as well as a barrier for innovations, as it can hinder new innovations from being developed (Danckwardt et al., 2019a).

According to Gorgolewski (2008), the construction industry needs to develop codes and standards for reuse of material and components to enable circular projects. The standard and codes should include approval for accepted procedures and promote best practice for resus of material and components, which will contribute to reassurance for designers and clients (Gorgolewski, 2008). Another standard recommended is the development of standards and assurance schemes to validate reuse of structural materials (Hart et al., 2019). Examples of parts that could be incorporated in a standard presented by Danckwardt et al. (2019a) were to design with circular usage in focus at all times, even when it's not requested by the client, to enable a long usability and future reuse, and to always include a life cycle perspective and reusability in design principles.

4.5 Process

A number of barriers found could be connected to processes that are present in and around a construction project, common ways and how things are normally done. In a circular project when material can’t be reused on site, it needs to go from one project to the next. Currently projects are often performed one by one with little to no connection to other ongoing projects (Minunno et al., 2018). This creates a barrier for actors to gain access to material present in other projects. Similar to this, the current lack of collaboration and insight between actors in the industry is mentioned as a barrier by Hart et al. (2019) both between business and well as between business fractions.

In addition to current processes hindering circularity, new processes and questions need to be tackled when implementing circularity. One such barrier concerns the ownership of the material from disassembled buildings (Singh & Ordonez 2016). Viewing buildings as material banks for the future also presents the barrier of their long lifecycle. As the owner might need to store the information of the materials and components used, as well as if changes of the building are performed, and plan for how this information will be handled if the building changes owner (Hart et al., 2019).

Studies also highlighted changes in the design and production phase when building with reused material. Designers and architects need to include end-of-life questions in the design, making their task more complex (Adams et al., 2017). The design phase is further affected, as having the information of what material will be used might not be present at the design phase. Information that currently can be crucial for the design team (Gorgolewski, 2008). This creates the barrier of an increased uncertainty and need for flexibility by the design team (Danckwardt et al., 2019b). To reduce the barrier for the design team, material can be purchased as early as in the design phase. Creating the new barrier of handling and storing the material until

production, which might as well affect the procurement process of a contactor (Gorgolewski, 2008). Furthermore, a general lack of routines for information storage is found to be a barrier as well as digital solutions to store the information about components and materials within buildings for later stages (Danckwardt et al., 2019b; Danckwardt et al., 2019a). As well as knowledge and requirement of digital documentation and information storage among all actors within the project (Danckwardt et al., 2019a).

A new demand on the role of the client is also pointed out as a barrier by Gorgolewski (2008). That the client will have to be more flexible and break norms to maximize the material reuse potential and adapt the project process. Something that is strengthened by Danckwardt et al. (2019a) who found that the client will, in a circular project, need to be more present in the project and be a facilitator for circularity instead of just setting the requirements, something that demands more knowledge, presence and engagements.

Several enablers for working with circularity are presented connected to the project process and organization. For clients requesting circular projects CE and reuse, it is important to have a clear business case to understand the commercial viability of the aim of the project (Adams et al., 2017). In addition to this, enablers such as procuring a circularity manager and/or a specialist role within the project responsible for the CE question is recommended in the study by Gorgolewski (2008). Other enablers recommended on the clients part is to focus on circularity from the start of the project (Ghaffar et al., 2020), as well as moving towards a system thinking about materials and installation in buildings, by moving away from single CE projects and enabling material and knowledge flows between projects (Hart et al., 2019). In the procurement process requirements that specify the use of reclaimed material can be formulated in a robust way to ensure the inclusion in the project (Gorgolewski, 2008; Ghaffar et al., 2020). To enable circularity, collaboration promoted by procurement requirements is requested, both to increase material flows and to adapt requirements to circularity (Danckwardt et al., 2019a). To transform the procurement strategy to promote non price criteria instead of letting the price decide the contractor (Danckwardt et al., 2019a).

During the design phase working with CE can be enabled by the use of existing tools and proper guidance (Adams et al., 2017; Hart et al., 2019). Working with digital design tools also enable new ways of information storage, simplifying circular measures in later stages of the building's life cycle (Hart et al., 2019). To include planning for the future dismantling of the building, already in the design phase is another enabler presented by Finch et al. (2021), with recommendations such as connections being designed to be assembled and disassembled by tools frequently used at site and that the dimension and tolerances regarding placements are designed to reduces the risk of damaging the components. Increased collaboration between the different project stages was also pointed out as an enabler to simplify working with circularity (Danckwardt et al., 2019b).

4.6 Engagement

A barrier towards implementing circularity into projects was by several studies found to be lack of interest and engagement both on an industry, urban top management, supply chain and individual level (Hart et al., 2019; Adams et al., 2017; Veleva et al., 2017; Mahpour, 2018; Hossain et al., 2020). A consequence of the lack of interest, presented by Hart et al. (2019) was an insufficient use of already existing tools to aid circularity. The reasons which are mobilized for explaining the lack of engagement are for examples a higher pressure on the design team to be flexible in adapting their drawings at late stages, an unwillingness among contractors to

bid on projects with uncertain methods (Gorgolewski, 2008), and low demand for demolition companies resulting in them not implementing methods for CE-deconstruction (Ghaffar et al., 2020). A preference for new material over reused ones by the end users of the building was also presented as a reason for the lack of engagement (Mahpour, 2018).

Regarding the client Ghaffar et al. (2020) found that the lack of warranty and possible additional cost for maintenance of materials and installations was a reason for low interest in demanding reused materials and installations. An issue raised connected to the unwillingness among the industry actors was the lack of incentives towards working with CE, both in terms of design and methods for material recovery (Adams et al., 2017; Ghaffar et al., 2020; Mahpour, 2018; Hossain et al., 2020). Connected to this, a lack of national goals, targets and vision can have a negative effect on creating engagement in circular projects, combined with findings of lack of commitment from top urban managers the engagement of national actors is seen as a barrier (Mahpour, 2018).

To tackle the lack of engagement within the industry to work with CE, some enablers are presented. Some successful examples where clients through their strong commitment have reduced the risk and enabled the time requested by designers are presented in a study by Gorgolewski (2008). Something that is strengthened by Hart et al. (2019) who promotes a strong environmental leadership and use of goals and sustainability measurements to promote the inclusion of CE within projects. To promote long term relationships between actors within the industry is also presented as an enabler to raise the level of engagement and reduce uncertainties within the supply chain (Hart et al., 2019). In addition, a clearer vision for CE in the construction industry in combination with acceptance and a translation from principles into practice is a possible enabler (Hart et al., 2019). Furthermore, when looking at the Swedish industry something that was found was the presence of a lot of interest, curiosity already existing among actors (Danckwardt, et al., 2019a ; Danckwardt et al., 2019b). Combined with a demand of reuse among many participants and parts of the industry, as well as an interest among many companies and administrations to be driving forces in the development towards CE (Danckwardt et al., 2019a; Danckwardt et al., 2019b).

4.7 Knowledge

Hart et al. (2019) mentions a lack of knowledge though the value chain both from suppliers, clients and internal actors as a barrier for CE in the construction sector. Supported by Danckwardt et al. (2019a) who found a general lack of knowledge regarding circularity at all levels and parts of the industry. The implementation of CE is affected by the lack of knowledge, since the construction sectors have short term goals in combination with a complex supply chain (Benachio et al., 2020). In addition, according to Benachio et al. (2020) the awareness of CE as a concept is good in the construction industry, however a lack of knowledge on how to implement the concept in practice is raised as a barrier. Mahpour (2019) and Danckwardt et al. (2019a) agrees with the complexity of converting CE in the construction industry in a barrier, but claims an insufficient awareness, insight and understanding of CE is also raised as a barrier (Mahpour,2019; Danckwardt et al., 2019a). A lack of common terms and language was also stated, creating a setting where terms are not interpreted in the same way by all actors, as well as creating misunderstandings and difficulties comparing tendering's (Danckwardt et al., 2019a). The lack of common language can also be connected to the lack of definition of CE and circular projects. Further, the lack of a common definition makes it difficult to develop a common industry standard (Finch et al., 2021; Ghaffar et al.,2020).

Gorgolewski (2008) mentions that the use of reuse materials entails a new complexity in the project and affects and changes the design and construction process. Furthermore, knowledge gaps about reused material reliability is raised as a problem, which may be due to resistance from owners and builders when there are alternatives, in other words using virgin material instead of reused material (Sanchez & Haas, 2018). Sanchez and Haas (2018) mention the lack of research based, user friendly methods as a barrier. In addition, the design team enters new challenges to anticipate economic, social and environmental challenges during the design process (Hossain et al., 2020). There is a knowledge gap in the pre-planning phase and it is incoherent. In addition to this there is a lack in the documentation from one project to another and between sectors (Sanchez & Haas, 2018).

Role model projects and an increased knowledge and experience sharing in the industry is raised as examples of enablers for adapt and increase CE projects (Nordby, 2019; Ghaffar et al., 2020). Knowledge sharing could be for example workshops and courses in cooperation with educational institutes (Ghaffar et al., 2020). Successful pilot projects may act as role models as a best practice study, for actors in the industry to benchmark and learn from (Nordby, 2019). Furthermore, a possible way to increase the knowledge could be shared platforms for actors to exchange experience (Hart et al., 2019; Ghaffar et al., 2020). Further, an awareness campaign is mentioned as a possible enabler by Adams et al. (2017) to increase the understanding about CE as a concept. In addition, Hart et al. (2019), mentions an increased technical development and innovations as possible enablers.

Providing education could be done in connection to renovation and demolition projects (Danckwardt et al., 2019a), but a general spread of information regarding tools and established knowledge within the industry is needed as well. As well as to establish a common definition to use within the industry (Danckwardt et al., 2019a)

4.8 Uncertainty, economy and time

Uncertainty is a barrier that was found in several articles, present in different parts of the industry, mentioned both as a general concern among actors, and connected to specific parts of projects (Mahour et al., 2018; Hossain et al., 2020; Gorgolewski 2008). The concern is connected to structural concerns connected to using materials after their initial end-of-life, and uncertainties of what effects circular material usage will have on environmental factors (Hossain et al., 2020). Danckwardt et al. (2019b) also suggests that an uncertainty about how to implement circularity within the industry has evolved due to the lack of hard requirements regarding circularity in procurement. The most frequently recurring uncertainty is connected to the economy. Not being able to oversee the value of materials put into the buildings at end-of-life (Hart et al., 2019). How the cost for demolition will change compared to traditional methods (Chini & Bruening, 2003), and a general uncertainty about the overall effect on the project economy (Hossain et al., 2020; Chini & Bruening, 2003). Uncertainty among contractors regarding risk and cost could also result in either driving prices upward or contractors making big losses when the complexity of the project becomes too high (Danckwardt et al., 2019a). The circular principle is not economical in comparison to the traditional linear principle (Ghaffar et al., 2020). The low prices of virgin materials become a barrier as it is not considered profitable to buy reused material (Hart et al., 2019; Finch et al., 2021; Danckwardt et al., 2019a). When including reused material, the quality materials must be controlled, a step that affects both budget and time (Grogolewski,2008).

The focus of reusing materials leads to additional costs and extended project times (Finch et al., 2021). Grogolewski (2008) mentioned extra design fees as a barrier, since the designers

need more time to identify reusable components to use in new projects, resulting in an extra cost for a project. In the production phase the dismantling of a building must be carried out carefully when the purpose is to reuse materials. A more time-consuming process compared to demolishing buildings (Minunno et al., 2018; Chini & Bruening, 2003). Currently there is no model for calculating and sharing the project cost over the building or materials lifecycle among the supply chain actors, including the maintenance and later stages (Danckwardt et al., 2019a). Another barrier connected to the economy is the fact that the value depreciation of buildings used today is not adapted to a CE. And a demand for a new way of valuing buildings at end of life connected to its materials must be developed (Danckwardt et al., 2019a). There is also a lack of funding to implement a CE approach in construction and demolitions waste management (Mittal & Sangwan, 2014). According to Chini and Bruening (2003) disposal cost of demolition waste is low, this makes it easier to demolish and not reuse.

Time is equal to money in the construction industry (Chini & Bruening, 2003), therefore the barriers connected to time also affect the cost. As the focus on time is currently valued very high and usually connected to economic incentives, this makes it harder for project actors to motivate sourcing reused materials and incorporating them in projects, as it could affect the project time (Danckwardt et al., 2019a). The short time perspective commonly used in projects today might also exclude solutions that can be more sustainable in a longer perspective, both regarding economic and environmental perspectives according to Danckwardt et al. (2019a). Matching the project times to collect materials further complicates the circular project process. As the ability to order materials "from the shelf" is erased, and the new step of having to plan for the material to be dismantled in one project in time for installation within the new project must be implemented. Something that is a major challenge for the current processes and project management according to Danckwardt et al., (2019b).

To use economic incentives specified in the procurement of a project is presented as an enabler by Danckwardt et al. (2019a). Incentives such as bonus systems and fines to motivate project participants to include reused material, reduce waste and other circular measurements. Furthermore, according to Hart et al. (2919) create a holistic perspective the importance of whole life costing is mentioned, to highlight the value of material assets. The focus of material in an existing building as an economic asset, instead of future waste (Hart et al., 2019). Investing more in innovative technologies in the construction industry is presented as an enabler, which may benefit future CE projects (Ghaffar et al., 2020). Small steps are adventitious according to Hart et al. (2019) who mentions taking the easy wins as a possible enabler for CE. If the CE is split into small steps the effect on the budget is reduced, small actions toward CE are better than no action at all (Hart et al., 2019).

5 Reference project

This chapter presents an introduction to LF and the result from the observations and interviews connected to the reference project including; Roles at LF, LF:s current focus on CE, Project structures, Different kinds of projects, The Bräcke School Project and The role and tasks of the PM at LF. The findins presented are based on observations, data gatherings and interviews with the LF supervisor and PM_Bräcke.

LF is a public client organization and manages around 1,500 facilities. LF is responsible for the technical requirement of public schools in the municipality of Gothenburg city and to make sure the buildings are being built and maintained according to those requirements, together with the request of LF:s clients. LF dominantly builds new schools either at undeveloped properties or by demolishing old buildings, they also have projects where an already existing school needs to be extended, or a combination of both. By combining the projects LF reduces the amount of projects disturbing the teaching at the school, and is a way to coordinate additional projects. Collecting projects that otherwise would have been needed to do in the near future.

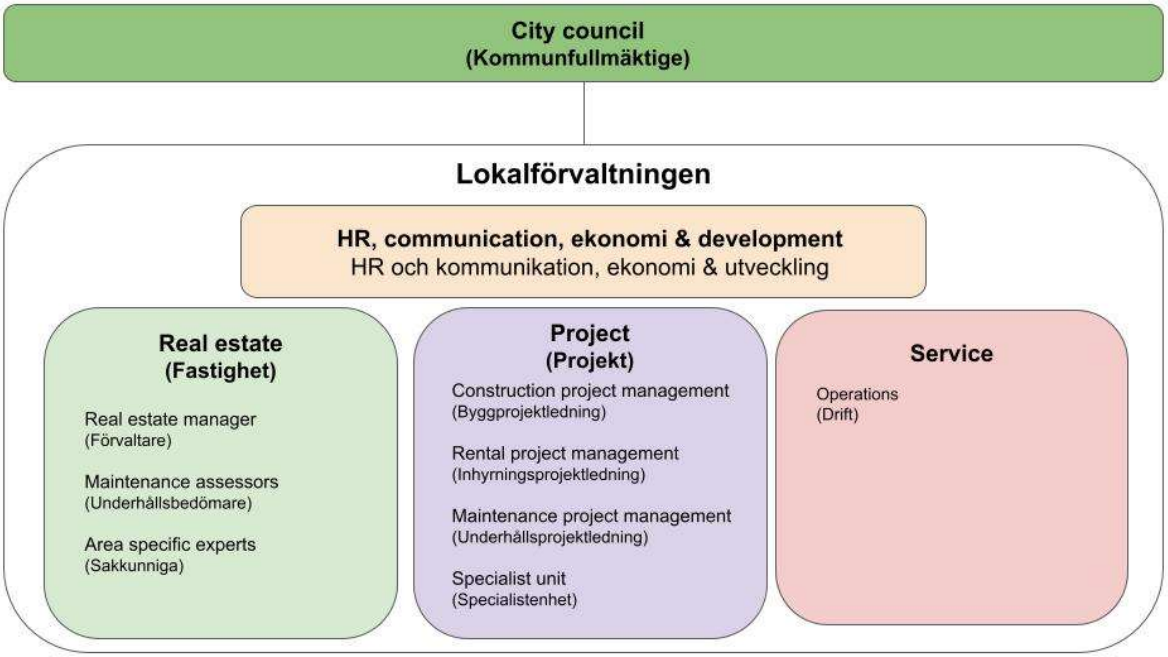

Figure 3 - Organization chart of LF.

LF´s organization, shown in Figure 3, is divided into four departments, a project department, a real estate department, service department, and a HR, communication, economy and development department. The real estate department is responsible for managing the existing building stock, together with the service department that operates the buildings. If an existing building is to have a major renovation or be extended, the project is handed over to the project department, who is responsible for all new production of buildings.

5.1 Roles

The PM is the role at the project department at LF that has the main responsibility over the projects, from the initial request from the client to the handover of the finished building. In larger projects the PM can be supported by an assistant PM working at LF as well.

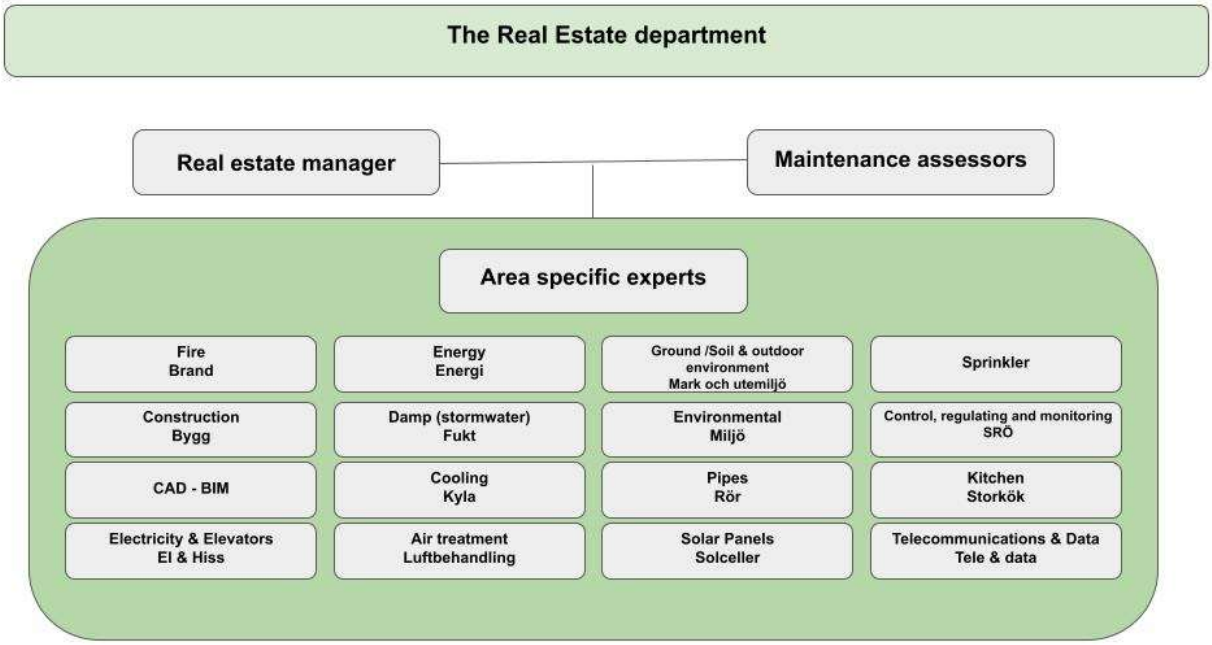

Figure 4 - Organization chart of LF real estate department.

At the real estate department, LF has area specific experts in the areas presented in Figure 4, working with questions, solutions and development of these areas. In all areas where LF has area specific experts LF also has technical requirements and instructions commonly known as TKA. Standards and practices that should be followed in LF projects, complements to laws, ordinances and practices in design and construction. With requirements such as, that all material used in LF projects must be listed in Byggvarubedömningen (BVB). These are available at the LF website for all project participants to read and understand, and they are implemented in the project specific documents. If a project deviates from TKA, the area specific experts need to be consulted to give acceptance for it to be allowed. A task performed by the PM of the project, as the area specific experts isn't a continuous part of the project organization. The area specific experts can also support the PM in complex questions if needed and depending on time. In all projects the area specific experts are responsible for controlling, and approving the project documentation at the end of the program and design phase, as well as the tender documents before the procurement.

5.2 LFs current focus on CE

LF has a sustainability focus as well as goals of working with CE, such as the definition stated in Chapter 2.2.1, but it is not fully implemented in the organization yet. There is a positive attitude towards CE at LF and some areas have gotten further than others. Some good examples are ground/soil, kitchen and SRÖ. When a demolition is commissioned, all departments are responsible for taking care of what is possible to reuse within their area. The area of Ground/soil has the routine and the possibility of storing material outside and use an outdoor storage. The area of kitchen has the routine of moving equipment from demolition projects into other buildings but does not use any storage per usual. SRÖ collects spare parts kept at service offices. In addition to ground/soil, other areas sometimes use the outdoor storage, but as no one

is responsible for tracking what is located there, the routine of checking the storage is not implemented properly yet, material sometimes gets forgotten at the storage.

As most of LF buildings are housing children, material and installations need to be properly fastened. This as children have the habit of picking apart installations they can reach and by curiosity wanting to take down and move material, also climbing on installations is common. This has created a focus within LF to secure material and installations to make it hard to take apart or tear down, something that the organizations know might complicate the reuse potential. Additionally, LF is engaging with research and is running the pilot project Hoppet focusing on building carbon dioxide free, that incorporates some reuse ideas. In 2019 the city of Gothenburg led a project, where LF took part, to create procurement requirements for circular flows in the construction and demolition process (Göteborgs stad, 2020).

"The purpose of the project was to increase knowledge about how public procurement can function as a tool to drive the development towards a circular construction and demolition process. The goal was to develop an action plan with concrete recommendations and proposals on how circular procurement requirements can be formulated and gradually developed up to year 2030." (Göteborgs stad, 2020)

The project formulated six goals for a circular construction and demolition process (Göteborgs stad, 2020):

1. Long service life and high quality.
2. More efficient use of material.
3. Small proportion of virgin materials.
4. Identify and keep materials for reuse and recycling.
5. Easy to repair, disassemble and reassemble.
6. Easy to reuse products that are built-in.

The project concluded that the current situation is far from the target image and that it is a greater challenge for the conventional construction process. The public procurement act is here praised as a forum to put pressure on the industry to start the journey and open up to more circular options, presented in the report (Göteborg stad, 2019).

5.2.1 The plan for the future

In the transition towards CE, LF has started plans to develop a material inventory, the routine should be in place in January 2022. The material inventory shall include construction, ground/soil, electricity, HVAC and SRÖ. The plan is that an inventory should be included in the ordinary maintenance by the real estate department. A specific inventory shall also be made when the project has an investment decision performed by area specific experts. The material will be assessed on three categories; dismantling capacity, economy and environment. The directly reusable material and when damage material could be fixed by internal service personnel will be recommended to be reused.

5.3 Project structure

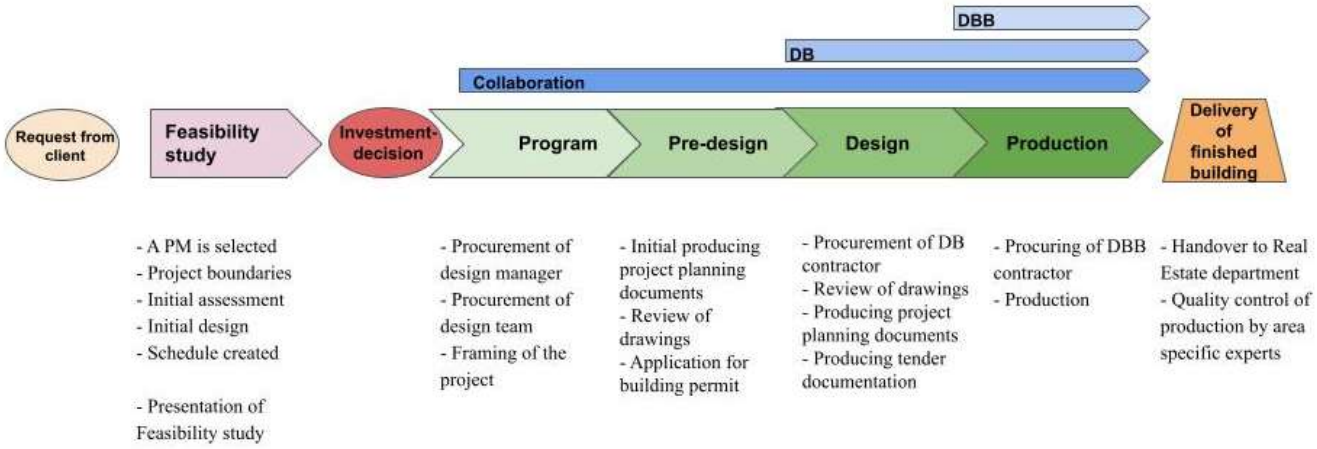

Figure 5 - A description of the project's different phases and the PMs main tasks in the phases.

As shown in Figure 5 a project at LF starts when a request for a new school comes from Grundskoleförvaltningen (the client), a municipal function in the city of Gothenburg, describing what functions the new school needs. The requested functions are translated through LF requirements and standards regarding design of schools into the specific areas needed. According to the PM, the project is usually quite open and not much is set by the client except these requests. The PM follows the project from feasibility study, through the creation of program documentation and project planning document, through the procurement process in design and construction, all the way to the delivery of the finished building.

5.3.1 Feasibility study

When a PM gets the task of a project the initial phase is to lead the feasibility study. The feasibility study identifies the condition of the property, and what the design and production phases need to handle to produce a result that lives up to the standard of LF and the request of the client. In the feasibility study the boundaries of the project are identified and set. Decisions are made regarding the internal project organization, and the internal roles are divided. To identify the condition of the property, assessments of different areas are commissioned by the PM, performed by consultants.

The PM plans and decides what type of assessment should be performed within the project together with area specific experts, making a project specific request. The consultant performing the assessment is then procured or chosen through LF framework agreements. The PM is responsible for making sure these assessments are performed to LF standards as well as specifying what assessments are necessary for the project, and to plan the order of assessments. If the project requires or should include any additional assessments beyond those who are pre-decided by LF processes and standards the PM can choose to include them. The task in the feasibility study is also to produce the initial design and volumes that could fulfill the request of the client and the standards a school should meet, and is feasible within the property.

Calculating the expected project cost, and to suggest a suitable procurement strategy, as well as creating a risk assessment for the project. Setting and initial schedule for the project, the project specific environmental and area plan. To be able to do this every assessment and step on the feasibility study is evaluated by the PM, the consultant performing the task delivers the result of their assessment to the PM, who either makes a decision regarding what should be

done in the area, possibly consulting area specific experts. Usually, the result is handed over to the consultant in the program and design phase to be solved in the next step. In this way the initial technical documentation for the project is created and all assessments and planning are controlled and accepted by area specific experts at LF. The result of the feasibility study is compiled by the PM, together with the expected budget and schedule. The compiled information is then presented by the PM, and an investment decision is given by Lokalsekretariatet.

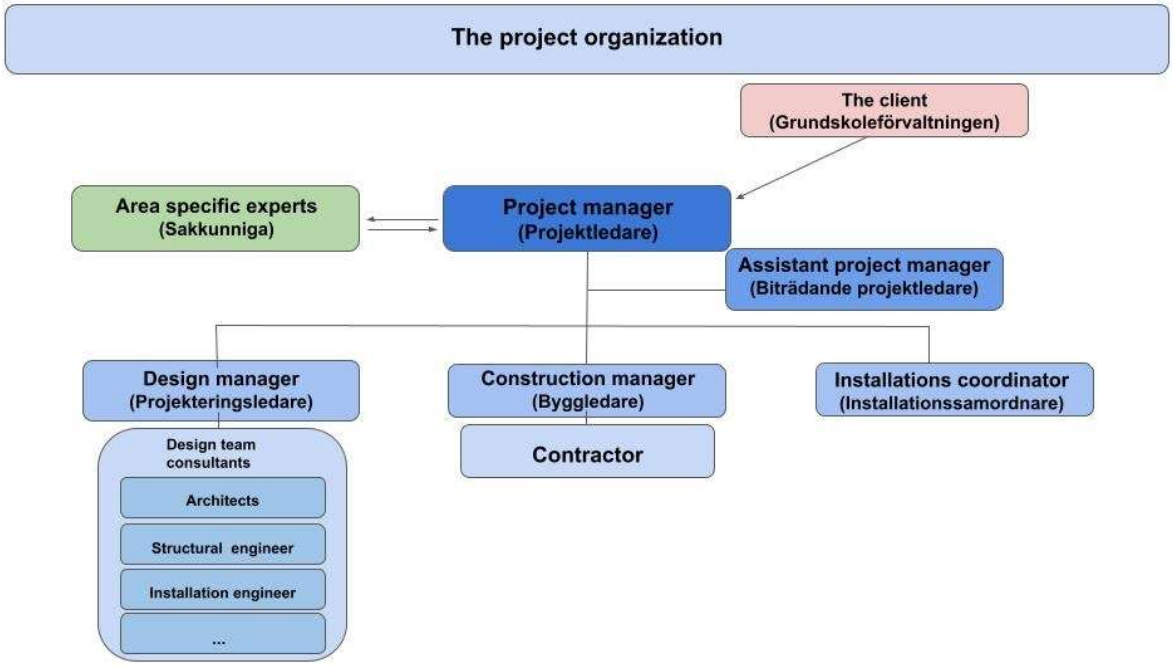

Figure 6 - Organization chart of the project organization

5.3.2 Program phase

In the next phase, after the feasibility study has been accepted, the task of planning the realization of the project starts. The project organization is reviewed and updated if needed, the result of the feasibility study is reviewed by the PM and an investigation of connected subprojects is performed. Assessments that by some reasons were not performed in the feasibility study, or additional assessments can be included in the beginning of the program phase. The aim of the program phase is to produce program documentation that determines the framing of the project from LF point of view, the technical standard requested, and the general shaping of the project based on the conditions determined in the feasibility study and the customer's requirements together with LF standards.

The PM is responsible for the procurement of resources for the program and design- phase seen in Figure 6. The PM procures a design manager to be the connection between the consultancy team and the PM. The PM compiles the specifications of the resources and consultants needed for the project. If the request fits a current framework agreement, she/he selects consultants and formulate agreement through that, otherwise a new procurement is done by the procurement unit. Usually, the consultancy team procured in the program phase stays the same throughout the design phase until the contractor takes over.

5.3.3 Pre-design and design phase

The technical documentation from the feasibility study and program- phase is used to decide the technical design of the building. The consultants are coordinated to create the final design of the building, the project planning document. The design manager leads the team and coordinates all areas. This is done in CAD and with digital tools. The PM attends design meetings, following the development in the project, making sure the schedule and requirements are followed.

The cost of the project and schedule is updated according to the project planning document which is reviewed by the LF area specific experts to make sure it lives up to LF standards and follows TKA. The application for the building permit is made and the project specific documentation is reviewed and updated. The tender documentation for the production procurement is created and reviewed. The project enters the next phase by procuring a contractor for the production. The PM attends interviews with contractors, with support from the procurement unit before an agreement is signed.

5.3.4 Production

During the production phase the contractor is responsible for the project and the PM attends budget and production meetings. As well as having the main responsibility if changes to the project plan need to be addressed, and handling the communication with LF area specific experts if needed. The PM procures a construction manager that is present within the project to simplify communication with the contractor and be the LF representative in the day to day, tasks within the production phase. The projects organization seen in Figure 6 also includes an installation coordinator, a role working parallelly with the construction manager having the main responsibility for all questions regarding the installations in the production phase. A newly incorporated role at LF. In the end phase of the project, the building is inspected and the area specific experts at LF are invited to take part. The care of the project is then handed over to the real estate department.

5.4 Different kinds of projects

In projects with existing buildings, the request from the client can be combined with the task of reinvestment within the existing building, renovating the existing building. The additional task comes from the real estate department at LF seen in Figure 3, who usually perform a feasibility study for the renovation which is handed over to the PM. How the presence of an existing building affects the project depends on what should be built as well as the state of the building. First and foremost the existing building comes with its own history and documentation. Everything from the original drawings to later refurbishments should be documented and saved as well as previously made assessments, and information regarding the state of the building. Additional steps in the project that need to be included is an environmental assessment, together with an overall quality assessment of the building in the feasibility study, preparing planning for and informing the contractor about a possible demolition within the building. As well as to document what material was removed after the demolition.

Some buildings have preservation requirements, and require an antiquarian investigation and careful renovations as they are protected due to having a cultural value for the area. In those projects an antiquarian follows the project. The role is active in the feasibility study setting additional requirements on the project regarding the execution and style of the design, reviews and sets requirements that need to be included to receive a building permit. The antiquarian

then follows the project through design and production, as a control function, making sure the project stays within the boundaries set.

5.5 The Bräcke school project

The school is currently a school for students age six to twelve, with 550 students, located in Bräcke, a district at western Hisingen in the city of Gothenburg. The Property consists of an original three-four floor building from 1948 marked as 1 in Figure 7, and a two-floor extension added in the 60:ths, marked as 2 in Figure 7. Both buildings are in need of major renovations regarding both the building envelope and installations, as well as a need for increased accessibility and size of the entire school.

The aim of the project is to renovate both buildings and extend building 2, as well as to produce a new building, marked as 3 in Figure 7, containing a cafeteria/kitchen, as well as lecture rooms. Building 1 is to be renovated (walls, windows, roof) and have installations installed, building 2 is to be remodeled from cafeteria/kitchen to lecture rooms, as well as get an extension of the current physical education building. When completed the school is to be changed into a school for students age ten to fifteen, with room for 720 students.

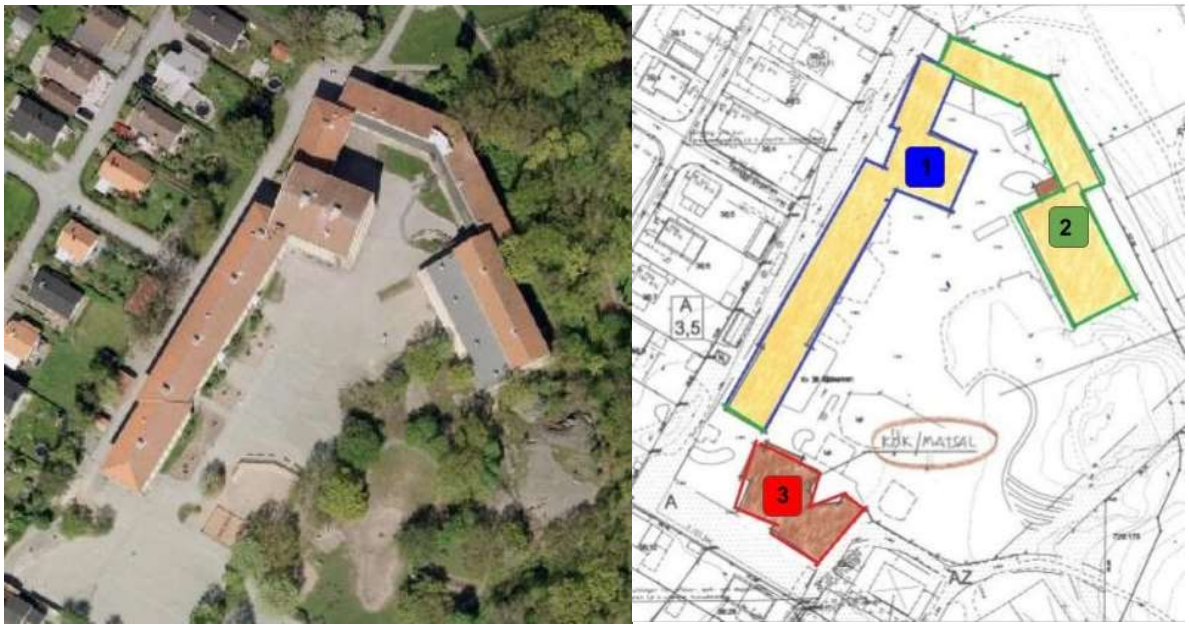

Figure 7 - The current Bräcke school and the plan for the Bräcke school, the current building is marked as 1 and 2, the new production is marked as 3.

The feasibility study at Bräcke school was performed during 2017 and the project has been through a variety of different plans and solutions. The initial plan was to demolish building 2, due to problems with humidity and stormwater, among others. But due to the cultural value of the school a renovation was decided instead. Regarding the role of the PM, the Bräcke school project has both a PM and an assistant PM, and the PM changed after the feasibility study. The project is in the program phase during the work of this thesis.

The reference project in this study is a combined new production, extension and renovation, making it a large, complex project. The budget is combined of both an investment and reinvestment task and the original building has some protection due to its cultural value. The projects are divided between two different contracts and will be performed separately in time,

with the new building being completed before the start of the production phase of the existing building.
In the feasibility study and in the initial parts of the program phase, some suggestions and mentioning of refurbishments and reinstallation of material have been mentioned. These are radiators with original 40tis character, fittings of good quality**,** some windows that have been replaced the latest years, kitchen equipment, furnishing and a general focus to keep the character and renovate with care, that is placed on the project as a result of the cultural protection of building 1. What will actually be kept or refurbished is not yet decided as the project is in its early stages.

In building 1, the addition of installations might take up space currently used for teaching, some functions in building 2 will be moved into building 3 to provide a better working environment, and standard. These are kitchen and dining, lecture rooms for craft, home and consumer studies and possibly art. New functions needed for the teaching will all be placed in building 3.

5.5.1 Complexities at the Bräcke school project

The divide of the project was chosen to solve the evacuation problem regarding the students, creating the possibility for the students to move into building 3 while building 1 and 2 is being refurbished. According to the PM_Bräcke this was necessary to solve the evacuation puzzle but has created an additional hurdle, as the disposition of installations and requirement for space in building 1 must be precisely calculated and planned for before the design of in building 3, as the combined space in the all buildings must meet the request of the client. When the decision was made the alternative of doing the projects at the same time and in opposite order was evaluated, and due to the evacuation, the order was decided.

Different contract forms were evaluated for the project. A collaborative contract was suggested due to the complexity of the renovation and the many evacuation stages that are to be expected for the students. For the new production a DB-contract was decided, as the complexity in that project was regarded as low and the need to get the project started was highly prioritized. The contact form for the renovation and extension is not yet decided, a collaborative contract would enable a contractor to get in early, something that could reduce the complexity regarding installations and logistics according to the PM_Bräcke, as well as increase the working environment. Experience at LF has shown that collaborative contracts can become quite expensive, and both a DB- and a DBB-contract is a possible solution. The complexity of the project creates a difficult situation for the PM regarding budget, as the distribution between reinvestment in the old building and the extension are requested by different departments and by different parts of the feasibility study.

5.6 The role and task of the PM at LF

The connection between the project and the PM can be described as the PM setting the requirements and having the responsibility for them being met within the project. Making sure the project participants are working in line with the requirements and that the finished building is what the client requested. The PM:s main responsibility for the project is the economy, the schedule of the project and the quality of the building. Along with making sure all involved within the project are working within the boundaries set by the client, and that fulfills the requirements set by LF.

The PM controls that the project follows the schedule throughout the project. Time is most crucial during the design and production phases, and is controlled by the PM during design and construction meetings, making sure the project is in phase with the schedule and checking if hurdles or uncertainties that might affect the schedule have arisen. Similarly, the economy is followed by the PM through project meetings and is connected to the times. In the design phase the consultants work on hourly commission, so that if the schedule is correct the budget should not be affected, something that is checked monthly by the PM. Setting the budget for the project is done by the PM, with support of area specific experts, knowledgeable in cost connected to the different areas. In the production phase LF usually uses a set price in the procurement, and the only additions should be ÄTAs, additional expenses that were not included in the procurement, that are discussed at weekly economy meetings to decide who is responsible for the additional expense if they arise.

The quality is followed by making sure the project team meets the requirement of the project. The design team has the task to make self-checks of their drawings, checking them to TKA, laws and regulation. The control by the PM is not done as regularly as with the economy or time. Instead a proper quality assessment is done of the delivered drawings at the end of each phase. As well as during two review sessions during the design phase. This is done as quality-checking unfinished drawings cannot be easily done. Instead, the consultants have to be trusted. The quality of the design and solutions is something that the PM says is difficult to handle as technical knowledge and experience is needed, and a PM can’t be an expert on all areas. It is about trust, experience and going on gut feelings if something doesn't feel right. Here the design manager is an important role raising the question to the PM if issues or concerns arise, as well as supporting the PM with more detailed technical knowledge. In the production phase the quality is followed in a similar way, controlling the documentation of the contractor, that they stay within the project boundaries, the PM also makes site visits. As in the design phase the construction manager here plays an important part to inform the PM if something doesn't seem right. The quality of the finished building is also controlled by the area specific expert before the delivery of the finished building.

The PM:s presence in a project varies between the different phases, with a high presence in the initial stages, when the decisions need to be made, and then reduced to a controlling and supporting function during the production phase where the PM attends the financial meetings and construction meetings still having the ultimate responsibility for the project. According to the PM_Bräcke the feasibility study is a more isolated part of a project as no investment decision is given and the realization of the project is unsure. The following stages feel more similar and the deviation between the different phases isn't as defined. The PM_Bräcke describes it as the different phases almost blend together. How present the PM is within a project deviates between different projects and PMs, projects with higher convexity or consultants that are new to LF procedures demand more presence, while much can be delegated in less complex projects. As many questions need to be solved and addressed in the program/design phase that automatically demand more presents from the PM, than in the production. In addition to this the PM_Bräcke also describes that the presence of the PM is connected both to the additional workload of the PM and personal interest. The PM usually has four ongoing projects taking place at the same time. PMs at LF are free to develop their own routine of how to run their projects as long as they develop projects that fulfill the client request and LF requirements.

The PM has the responsibility of communicating with the internal LF organization, contacting area specific experts when needed, as well as preparing, contacting and informing them for

their inclusion within the project. For example, regarding kitchens who need to be made aware if old equipment is present within a building, so that they can examine the state of the equipment and decide what to keep or move to another project. The PM is also responsible for fulfilling their verdict and informing the project participant of what needs to be done. According to the PM this is an internal routine procedure, usually performed by making a call or sending an email, and their verdict is included in the project documentation.

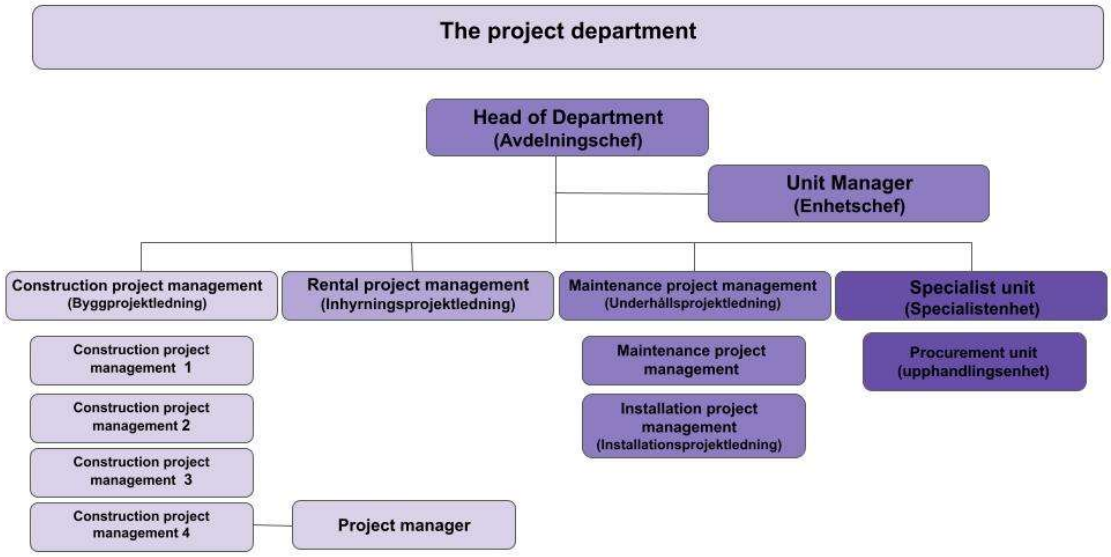

Figure 8 - Organization chart of LF project department

The PM decides within the project budget what steps should be added regarding the renovation in the project. One special case is if environmentally hazardous materials are found, a dialogue must then always be conducted with an area specific expert. LF strives for non-toxic materials in its buildings and if the building contains toxic materials, they always have to be removed. As it otherwise, it will be difficult for future administration to know if not all toxic material is removed.

If the PM realizes that a project will be exceeding the budget, a higher managerial level seen in Figure 8, needs to be consulted, to extend the budget. This could be if asbestos or other toxins is found in many parts of the building, which would extend the project to remove all material, or if an option with a high environmental gain is suggested but is more expensive than the lesser. In cases where the budget is higher than needed the PM does not have the freedom to include unmotivated additional parts, instead the money is handed back. A hurdle connected to the budget is the expenses created in the feasibility study when the project might not be realized. Something that is seen as somewhat problematic within LF as the feasibility study is done on key ratio level given by the internal organization, something that can lead to not including proper assessments to keep cost down, resulting in misleading results. According to the PM_Bräcke this creates a focus on keeping the cost of the feasibility study down, making it hard to motivate additional steps or expenses, as the financing is unsure. A result of this is that some suggestions in the feasibility study aren't always thoroughly investigated, and opportunities might be missed in the following phases if the PM doesn't initiate a detailed investigation later on. The work of the PM is dominantly followed up through the checkpoints within the project. That the checkpoints are performed is controlled by the PM:s superior, who also has monthly reconciliations to support and help the PM develop in their role. The PM also mentioned that they and their projects are evaluated regarding budget, time and quality, areas which are measured and documented at LF.

6 Empirical result from external actors

This chapter presents the result from the interview study with external actors in the Swedish construction industry. The answers are summarized and divided under the different headlines: Processes, Economic and Uncertainties, Complexities, Knowledge, Engagement, Standards & Certification, and the most important step for implementing CE in the Construction industry.

The interview study was conducted to gain a greater perspective on CE in the construction industry in Sweden. The respondents work at companies that are ready to work with CE by providing reuse management, reuse inventory, material inventory and reuse coordination. The interviews are presented in the Table 4.

Table 4 - A presentation of the external actors interviewed.

RESPONDENT	ROLE IN THEIR ORGANIZATION	DATA COLLECTION
CONTRACTOR 1	Sustainability Strategist	Interview
CONTRACTOR 2	Construction manager	Interview
ARCHITECT 1	Architect	Interview
CONSULTANT 1	Installation consultant	Interview
CONSULTANT 2	Structural engineer	Interview
CONSULTANT 3	Management consultant	Interview
CONSULTANT 4	Management consultant	Webinar
CLIENT 1	Sustainability Director	Webinar

6.1 Process

All of the respondents agreed that they want to be involved in projects as early as possible. Some examples from Contractor 1 and Architect 1 are that they want to be involved at least before the demolition works begin, but it's hard to define a specific time. Contractor 1 adds that if the contractor gets involved as early as possible it will increase the opportunities/possibilities for a successful circular project. Furthermore Architect 1 mentioned that they want to be involved in the program phase, or as early as possible. According to Consultant 1 they have experience of both getting involved in early phases such as in the program phase and late when the demolition works have almost started. Consultant 1 prefers to get involved early because otherwise it becomes more difficult.

"[...]it is more difficult to keep up, you have to clear time in calendars to have time to go out and look, compile materials and so it is, there is a chain that is not completely in place" Consultant 1

According to Consultant 2 the workflow both differs and not differ from a traditional project. In a circular project it is important to be in the project in the early phases, and Consultant 2 also mentions flexibility as an important part in the design since you get to work with the material you have, the door may not be identical in size and shape in a building when working circularly. Architect 1 agrees with Consultant 2 and adds collaboration in the project group when working with circular projects as an important part. Client 1 adds that the flexibility in the design implies limitation for the architects and currently the architects are divided into two camps. Client 1 explains that one of the camps think that the limitation hinders their work and creates a negative mindset toward CE, and the other camp thinks it challenges their creative ability and creates a positive mindset. Contractor 1 mentions the workflow differs from a

traditional project in terms of more in-depth inventories in circular projects. The in-depth inventories are more time consuming.

"It is clear that it takes a little longer time to care for the materials than to just tear it out of course [....] because currently we do not have a storage that large, where we can only go and buy like this 100 doors." Contractor 1

According to Contractor 2 the access of materials differs from a traditional project to a circular project. Contractor 2 explains that if you have for example 13 steel pillars and you want to build a 4 storey building you need to consider the structural parts. The result may be that you can't build 4 floors, instead you can build 3 floors with the material you have.

Consultant 2 mentions the unclear business case, goals, and policy instruments in organizations as a barrier. In every organization's line, policy instruments are needed, because each project is like its own small company. Circularity needs to be high on the agenda in the entire organization. If the management in the organization puts an increased focus on circularity in the project on the top of the agenda it encourages the employees to work and report progress toward circularity.

6.2 Economic and Uncertainties

Economy is a barrier mentioned by Consultant 1, 2 and 3 and Contractor 1. The lack of economic incentives is mentioned by Consultant 2 as the biggest bottleneck for circular projects since the uncertainties and concerns about increased costs connected to new circular methods. Further, Contractor 1, Consultant 1 and 2 mentions the low price of virgin material as a barrier since it is cheaper to buy virgin material than reused material.

Consultant 1 mentions the flexibility as a difference between a traditional and a CE project, as in traditional projects you order for example 100 sinks from a brand and then you get 100 identical sinks. In a circular project when purchasing material there is an uncertainty when ordering material. You can't probably order 100 identical sinks. Consultant 3 agrees with Consultant 1 and mentions that you start with inspecting the material that is available and then you design after that range.

According to Contractor 1, a request from clients is an enabler, as then the company's starts to work more with the finance part. Because it is expensive from the start before you get a spin on it. Contractor 2 mentions that the economical model for waste management needs to change because then it is noticeable when you leave behind a lot of spill in the workspace. Then you will be more careful ordering materials to the right amount to cut some costs.

6.3 Complexity

Complexity regarding materials is mentioned by Contractor 1 and Consultant 2. They conclude that it is more complex to buy reused materials and easier to buy new virgin material. Both Consultant 1 and Contractor 2 mention the linear systems thinking approach as a barrier.

"We have a system that is built around consumption. So it's probably a bit of wear and tear that everyone has set up their production line to fit in with it, and it will be very difficult to slow down and adjust the industry to be able to start working more with reuse, for example. "Contractor 2

Client 1 mentions the risks with access to reused material as a barrier that increases the complexity in circular projects. Architect 1 mentions sorting out the liability issues regarding materials in early phases in a project, writing an agreement or similar in which the actor takes responsibility if something breaks. Architect 1 gives an example of a “reuse trust”, who can assist with finance if problems arise due to the choice of using reused material.

6.4 Knowledge

According to Consultant 1, a certain type of knowledge disappears more or less, for example, there are only a few companies that restore for example windows. Since these types of companies have had difficulties fitting into a linear economy, there has been no demand, which means that the knowledge of renovating also becomes deficient. Consultant 3 mentions knowledge as a barrier, the knowledge of how to work and how to take on your task in a circular project. Consultant 3 mentions that one enabler is to have a clearer vision and goal that permeates the process. Consultant 3 adds that it is very important to coordinate the consultants to work and think along the same lines. If you have 70-80 consultants working in the project, you suddenly get 70-80 brains working with it, and then a lot happens.

According to Consultant 1, consultants have an important part, both to influence and inform the client that it is entirely possible to demand CE and that it is not strange to set up requirements and asking for circular projects. To be able to as a consultant to help the clients to tear down the wall of complexity and uncertainties of what can be demanded and that it is possible.

The respondents were asked about the definition of CE and all respondents have different definitions on CE and didn't have any common definition that they referred to. For example, Contractor 1 explains that reuse, recycling and waste management are the three parts of the CE. Both Consultant 2 and Architect 1 explain CE in terms of managing resources and building and thinking resources efficiently. Consultant 1 explains it in a contrast to linear economy where there is a clear start and a clear end and in a CE materials never reach the end of their life you repair, update and try to make them last longer.

6.5 Engagement

Lack of clients requirements is mentioned as a barrier by, Consultant 2, Consultant 1, and Contractor 1. Consultant 1 explains that in order for change to take place towards a CE in the industry, it is required that circularity is demanded by clients. Contractor 1 adds that there is a need for requirements from clients since in current projects, the contactors sometimes are the ones suggesting to work toward circularity in projects. According to Consultant 4 tradition and habits is a barrier for circular projects since people want to work as they always did in the past. Further, Contractor 2 mentions the view of secondhand in general as a barrier, as it would be stale or dirty. This kind of mindset gets stuck in people's thoughts, which affects the customers' approach towards reuse of material as something ugly and not trendy. This is strengthened by Client 1 that also mentions the view of secondhand as a barrier as the customer believes that the second hand is not nice and they want new materials.

Consultant 1 explains that the current linear system in a combination with the attitude of doing things that they have always been doing makes CE challenging. To be able to change this pattern the clients need to make an active choice of requesting circular projects because then a market is created and the consultants have to adjust to the market. The current system is beneficial for many actors in the construction industry according to Consultant 1.

According to Consultant 2, it becomes powerful if a desire for a change comes from the client's side, a demand from the clients is an important enabler for circularity in the industry. Regarding the customer's view of secondhand, Client 1 claims that by showing possible customers successful projects where they can't even tell that the project has been including reused material. This view from the customers can be changed and the engagement can change.

6.6 Standards and certifications

Certification of reused material is a barrier according to, Consultant 2, Architect 1, Client 1, and Contractor 1. Architect 1 mentions the reuse part as an obstacle since requirements on projects using BVB on all ingoing material in the project, complicates the use of reused material. It is more difficult to get the reused material in the construction product assessment systems, which complicates the process. Contractor 1 agrees that virgin material is less complex, one reason being BVB. Further, Architect 1 explained that problems connected to CE-marking and warranties are topics that often arise, and a solution is needed. Client 1 and Consultant 4 agree with Architect 1 regarding warranties of reused material as a challenge. Client 1 mentions that warranty and responsibility issues often arise when reused material is involved, but when it comes to "normal" renovation projects this is not considered a problem for the contractor. The barrier could, according to Client 1, be solved by viewing CE projects in the same way as renovation projects. If the contractor claims that they cannot give any warranties for their work, the client should ask them to specify what exact part they mean. As most part will probably be their normal work, and in that way only exclude the warranties for the reused material.

6.7 The most important step for implementing CE in the construction industry

Stated by Consultant 1, 2 and Contractor 1, 2 the most important step to implement a CE in the construction sector is a demand from clients. Contractor 1 mentions that if client requirements exist, you will start working with the financial part. But if you know that there are continuous client requirements, we and our competitors will dare to invest, which in turn will put a spin on the circularity of the construction sector.

"Public customers clearly have a role to play, I mean it is a classic role for public customers to go ahead and show others that this is entirely possible, it's just like that you usually have to work with large municipal investments. I would say that we have a solution there". Consultant 1

Consultant 2 adds the importance of starting early in planning with a circular project, since the idea should be clear from start, and the common thread should permeate all the different phases of the project.

According to Architect 1, there must be stricter legal requirements and stricter requirements from the industry, to be able to implement a CE in the construction industry. In addition to stricter requirements, several actors in the industry need to become role models and dare to take the lead and show that it actually works.

7 The PM_Bräcke´s reflection of the selected topics

This chapter presents the reflection of the PM_Bräcke on the three selected topics. The selected topics are; Processes that are currently circular at LF connected to renovations projects, Collaboration between internal projects and PM´s to increase reuse material exchange and Material inventory as an enabler to identify the reuse of material in the renovation projects.

7.1 Processes that are currently circular at LF connected to renovations projects

Processes identified by the PM_Bräcke in the Bräcke school project is the renovation as a circular process, and that they try to save as much material as possible.

"So in this project it is that we rebuild and try to save as much as possible and not tear down and build a new school" PM_Bräcke

Further, the PM_Bräcke mentions that reuse, demolition, and reassembly is something LF has not worked with in the past, but the PM_Bräcke points out that this is something LF needs to develop to become more circular. In the Bräcke school project observation and suggestions interpreted as a proposal regarding, reuse, reassemble and minimize is present in Chapter 5.5. The PM_Bräcke confirmed that this is a quite normal amount in a renovation project. In this project, there is no "equipment" on the outside such as swings, otherwise, that kind of object is easy to preserve. The PM_Bräcke adds that the amount of reuse suggestions could be seen as unusual if you compare it to LF´s project portfolio, where much is new production where no reuse is present at all.

"There are many projects where there is a school, where you just level it with the ground." PM_Bräcke

Further the PM_Bräcke explains that there are several reasons for the choice of demolishing existing buildings, the first reason being that the client suggested it in the project description. That a new school shall be built on an exciting school plot and then a demolition of the existing school is included. However, the PM_Bräcke adds that they have the opportunity to affect the decision in the feasibility study by suggesting a restoration instead. This can for example, be done by promoting a more sustainable solution that fulfils the requirements. Other reasons that affect the decision of demolition are complexity, the condition of the existing building, the costs as well as the engagement of the PM. The overall quality assessment presented in Chapter 5.4 is included as an LF process today. The PM_Bräcke evaluates the material located in the building whether it should remain or not, as a standard moment in her/his renovation projects.

"I would say that it is a fairly standard procedure. [...] if they meet the requirements we have, then they should of course remain. It is no idea that we replace things that are in good condition. And we have that process in all renovations, or at least I do. Now I can not speak for everyone at LF, because I have not been here that long. But in my rebuilds, it has always been so." PM_Bräcke

The areas where reuse of material or component is investigated or is mentioned is more common at the constructions part than the installations part. The PM_Bräcke explains that the focus when it comes to installation parts is not the condition, but the system structure. To be able to get the function that is needed from the system. The general attitude is to try to keep the installation if they are working. Further, the PM_Bräcke adds that it is more difficult to

identify the quality of the single parts of an installation system, to find the weak spots that need to be corrected. Construction parts are easier to compare with requirements, an example is if a door meets the sound requirements.

Currently there is no routine or compilation of information when someone in the projects suggests to save or renovate material. The information is documented in protocols from meetings where the topic arises. The PM_Bräcke mentions that if they want to have this kind of information in the procurement documents the information from meetings will be used. If a discussion appears regarding reuse of materials or component the process, the PM_Bräcke will raise the question regarding the life cycle perspective:

- Does the material last for another lifecycle?
- Can the material be refurbished?

Then the economical aspects versus the life cycle perspective needs to be taken into account. The PM_Bräcke usually makes the decision based on the statement from the consultant doing the assessment.

"If a radiator has a life cycle of 50 years and the present radiator only has 10 years left of the lifecycle and if the cost between buying a new radiator and restoring the old radiator will be equal. Then it is not justifiable to keep and restore the old radiator since new radiation will simplify the maintenance." PM_Bräcke

When asking about the PM_Bräcke´s thoughts on preservation requirements as a current enabler for material reuse. The PM_Bräcke explains that it is important to separate the antiquarian's thoughts with the requirements that have been set in the document regarding the preservation requirements. Some parts where the antiquarian suggest preservation of example a wooden panel. The wood panel can interfere with the design that the school needs, which in turn can affect how the school can use its premises later. The classroom may not be able to get the size needed to bring in 20 students instead of 30.

"You also need to be clear to the antiquarian that these requirements that you have set in your document, are they really a requirement or so that you think we should preserve this." PM_Bräcke

If the PM_Bräcke would get a requirement to compile which steps they are doing today that can be connected to a circular process, then the PM_Bräcke himself/herself should not have done it. The PM_Bräcke explains that she/he had hired a consultant to perform the task and that he/she would also contact those who have knowledge of the building internally.

"I had probably listened to those who have knowledge of the building. There are things that may be physically in good condition and can be kept, but might not work here. [...] Even if it is in good condition in terms of product." PM_Bräcke

When asking if the requirement instead would be to document everything you cannot reuse, had it been compiled in the same way, and if it would have been more favorable. The PM_Bräcke explains, if you make a list of only what can be reused the opportunity to write nothing exist, but you can't do that if you do the opposite. From that point of view, it may be an eye-opener that you have to think more actively about the reuse potential. Finally, when

asking if the PM_Bräcke´s consider a responsibility as a PM regarding circular processes. The PM_Bräcke explains that she/he sees a great responsibility regarding circular processes today, but the responsibility is currently at a personnel level and the PM_Bräcke adds that currently there is no clearly defined reasonability at LF.

"Purely in gut feeling and conscience-wise, I see a super large responsibility. Then I do not see that there is a clear delegated responsibility from LF. But for me, it's more that I think it's important personally as well." PM_Bräcke

7.2 Collaboration between internal projects and PM´s to increase reuse material exchange

At present, there is no clear collaboration between projects and PM:s at LF. According to the PM_Bräcke**,** there is no collaboration among the PM:s within projects and the insight into each other's projects is quite low. At the same time, the project department is said to be quite good at knowledge transfer and learning from each other. The communication between PM:s is also good and normally they work close to each other making it easy to ask for support or feedback. The PM_Bräcke mentioned Covid-19 as a problem for collaboration since it's a bit unclear if it is because the colleagues are not seen at work or if it's so general.

If a project would exchange material with another project within LF, then the additional cost of dismantling instead of demolishing would be taken by the receiving project. Internal projects wouldn't buy materials from each other, instead, they would pay the extra costs that arise. The PM_Bräcke explains that the hardest part would be to value that work and to get the contractor to differentiate what the additional cost is, due to having dismantled instead of demolishing.

The planning between projects would become difficult according to the PM_Bräcke, since the uncertainty of the project being realized is present in the early stages and the project schedules need to match if no additional storage is to be used.

"Because maybe a project does not get a building permit and then all of a sudden the second project has 20 doors that have nowhere to do. That is probably the largest problem."PM_Bräcke

When asking if it would be possible to overlap the two projects at the Bräcke school, the answer is no. The main issue is the stakeholders because it is not possible to evacuate the students to another building. Another scenario would be if there had been an external evacuation somewhere that they could have used because then they might have been able to both the renovation and the new production at the same time. An evacuation to an additional temporary building had entailed a large financial cost, which makes that scenario complex and not suitable for this project. The PM_Bräcke sees no project benefits from overlapping the two projects.

The PM_Bräcke was presented with a fictional scenario where the Bräcke projects would overlap and a number of interior doors demanded in new production could be dismantled in the renovation (without intermediate storage, excluding schedule and quality assessment). In response to this case, the PM_Bräcke says that the focus should be in the design phase for the new production and in the program phase for the renovation. The PM_Bräcke would need to make an inventory and synced these two projects in the design phase. The PM_Bräcke adds that you make the decision to make a reuse inventory in the renovation project means that you

get a lot of information for free later in the project. The inventory will ensure the amount of material that can be moved between the projects. The PM_Bräcke would inform the contractor of setting demands in the documents and by clearly setting requirements for how they would do in the project. Further the PM_Bräcke clear dialogue about this during the course of the project. The PM_Bräcke also mentioned that in this scenario to do everything at the same time, they probably would not have had two contractors, only one contractor that would have facilitated that question.

In the case of two contractors in the projects and an overlap in the two projects, then the focus on reuse would probably be on loose furniture such as a sink in a classroom. Things that you can disassemble and reassemble in a rather late phase. This would become an additional step, which means that the PM needs to have coordination meetings with the two projects and ensure that the times are right. One contractor may dismantle while the other is given the responsibility to reassemble it. In addition, the PM_Bräcke suggests a second solution that a third party will be responsible for the dismantlement of materials. The daily responsibility and control would not be on the PM but on the construction managers according to the PM_Bräcke. No additional support would be required from LF, because much of the responsibility will be on the construction manager. In addition, if the PM_Bräcke would only be responsible for one of these projects, either the renovation project or new production, the most important communication with the other project would be the availability of materials. What is available, in what dimensions and quality, to be able to know what can be used. This information must be in place in the early stages in order to be able to procure a contractor and specify the times.

"We have to set requirements in the contractor's task and then we must also at an early stage before we procure also be clear with times. What are the times we have to relate to, and they must also make demands on times for disassembly in their tender, of course, so as to sync them."PM_Bräcke

The PM_Bräcke adds that the biggest bottleneck with this scenario is the time and the energy to adapt to another project.

"Well, it's the time. In other words, the energy it takes to have to adapt to other projects is an obstacle." PM_Bräcke

When asking about what is required to enable collaboration between PM:s as LF, the PM_Bräcke explains that, to be able to create a collaboration between PM:s at LF regarding a material exchange, an internal support system needs to be in place. The internal support will include someone who has an overall view of the various projects. Who has the responsibility to keep track of the different demolition, renovations, and new production that are planned for in the future at LF, and what materials are available in the different projects.

"That someone is responsible for building up a database there and actually pairing project managers with each other. I think that would have been a great help." PM_Bräcke

The PM_Bräcke thinks that the consequences of increased collaboration between PM:s are different behaviors of changing their current process. An internal support function that coordinates the various projects will be very important.

"[..] it is a new process to implement in their way of working. So there will probably be some resistance in the beginning, I would think. But it is probably still, but it is a positive role, it is

good that it is there so you do not have to take it as well, have to do the detective work. If it did not exist, it would take more time and mean greater complexity." PM_Bräcke

7.3 Material inventory as an enabler to identify the reuse of material in the renovation projects

As mentioned in Chapter 5.3.1 in the feasibility study it is possible to include to do the investigations the process is quite flexible. If the PM's task would be to identify directly reusable material. The PM_Bräcke mentions that a decision to do a reuse inventory would take place in the feasibility study, to include that focus in the project and to account for it in the budget. One option mentioned by the PM_Bräcke is to do the reuse inventory in combination with the environmental inventory, to avoid suggestions of saving toxic material which still has to be demolished due to environmental reasons.

"[..]it is easier to get a reuse inventory in, alternatively that you need to take the budget into account to make a reuse inventory because it costs a little money as well. " PM_Bräcke

Further, the PM_Bräcke mentions the internal support function requested earlier, a coordination function that will remind the PM:s to do a reuse inventory. There are no new consequences for PM:s to add an extra checkpoint such as material inventory in a project. According to the PM_Bräcke, it is an additional procurement to do and maybe a start-up meeting then it is a process that is quite self-sustaining.

Three different suggestions were presented on how a material/reuse inventory could be implemented:

1. Material /reuse inventory would take place in the same way as an environmental inventory, in which a consultant gets the task of assessing the entire building. (current order, contact, follow-up).
2. The area specific experts will do the inventory of the areas connected to them.
3. Material /reuse inventory would be added as an additional step in each existing investigation that is currently being done in the building.

According to the PM_Bräcke there are pros and cons to them all. The PM_Bräcke explains that the first and third alternative is a bit interconnected, since you bring in a reuse consultant, they will take the help of, for example, an HVAC consultant to get an insight into what is available and what can be saved. The second alternative could be a good idea since the internal staff has a better insight and it will be easier to map and merge the projects as well. The PM_Bräcke is concerned that there are not enough internal resources to be able to carry out inventories in all projects.

"If there is a concern that we have such an incredibly large property portfolio, there are a lot of such inventories that need to be made and I am afraid that so many internal resources will be needed that in fact, no one will keep up with it"PM_Bräcke

The PM_Bräcke thinks that the opportunity to make choices based on the inventory becomes narrow if it is an internal resource, because then it is they who will require what we need to save and not. If it's an external resource then is it an extra procurement that needs to be done, but if it is a framework agreement then it is not a major burden. There will be the same number

of meetings with all options. Further from the financial point of view, the internal option would be less expensive because the internal resources would have low hourly charges in projects. The PM_Bräcke also adds that it is difficult to say how the different options would have affected the budget. A combination of alternative 1 and alternative 3 is the best solution according to PM_Bräcke.

"I think 1 and 3, that there is a main with input from the experts or specific categories is probably a winning concept I would think."PM_Bräcke

When asking whether a material inventory should be included as a mandatory step in all projects to bring in the routine or whether it should only be done in projects where previous investigations show that there is reuse potential. The PM_Bräcke thinks that it should be a step before the inventory where you consult with an expert who is in charge of reuse whether it is a suitable project or not. Introducing mandatory material inventory in all projects would not be the way to go according to the PM_Bräcke, and adds that a checkpoint in all projects is relevant.

To consult with the internal support function and if they think a material inventory should be done in the project or not. The PM_Bräcke develops and says that the inventory itself should not be mandatory, but the checkpoint should. The checkpoint could be either to discuss it with an internal support function or that there is a list with a certain number of criteria that should be met. Finally, the PM_Bräcke suggests that LF propose that a project should have a reuse focus, but the amount and what material that will be included is decided within the project organization. The PM_Bräcke explains that herself/himself and those who work daily in the project should be the ones who get to make the decisions regarding what you disassemble or reuse in this project because those who are involved on a daily basis in projects that have the best knowledge about judging, this is something we gain from doing or not.

"But that someone comes in from the side and says this is how you should do your project. I do not think that is a winning way to go. But I think you need to be very humble for the person who leads their project, that they have a good attitude and maybe then can help guide them so that it does not become a pointer. Because it can upset more than it provides as well. Then no one will do it in the end." PM_Bräcke

The PM_Bräcke thinks the "forced-solution" is the solution that will result in most reuse in the end, however, the PM_Bräcke would not recommend that type of solution. This type of solution will probably lead to a deteriorating working climate and may affect the quality of the building and this is an aspect that needs to be taken into account.

"But I do not think it provides a particularly good working climate and it may also happen that we don´t pay attention to the quality then. That you may not have that aspect with you. That is, what kind of building do we get and what function do we get when we are ready. It is clear that you can snowball into a perspective as well, to reuse for the sake of the environment purely in the construction phase. [...]you can not just say. Well, we will certainly reuse it, even though it may cost several millions to actually do it. Because the material does not last for disassembly and reassembly even though it was thought from the beginning. So you will need to be a little responsive. in the projects what we have for specific conditions." PM_Bräcke

8 Discussion

This chapter presents the analysis and discussion, the initial part presents a general discussion with the focus on the reference project, and the second part of the discussion presents the barriers and enablers regarding circular processes connected to the PM and structure at LF

After following the PM_Bräcke and reviewing the processes at LF and the Bräcke school project it is clear that there is no defined CE focus implemented, and as the PM_Bräcke states LF has not had a focus on incorporating reused materials in their new production projects.

Three areas have been presented as role models at LF where some reuse practices have already been implemented. The most frequently mentioned is the work of kitchen. The PM_Bräcke presents a simple and well-established routine, but as presented the routine isn't perfect, as only equipment that can be directly moved to another building without storage is kept. Well-functioning equipment will still be wasted if there is no demand for it within LF at the time. The outdoor storage used mostly by ground/soil is another role model routine. A reason for it not being brought up in this review might be the lack of yard and playground equipment at the Bräcke school. The practice at ground/soil seems to be similar to kitchen with the addition of a storage site, solving the time issue and enabling more reuse of equipment. Looking forward, if LF wants to transition towards more circular processes some changes are needed to be made. But these areas could probably stay the same or be easily adapted.

Other examples of processes that can be translated to circular ones were found in the reference project. Initially the old building was planned to be demolished, something that was changed due to its cultural value. An antiquarian is now present throughout the project, to set requirements of actions that can and can't be done within the building. Putting a value on original features, and possibly awakening the thoughts about careful renovation in areas where cultural protection isn't a requirement. Further, the PM_Bräcke describes the image of not wanting to change equipment and materials unnecessarily in renovations project and that an inventory of the quality of the building is a routine procedure in renovation projects, at least in hers/his, routines that simplifies the transition towards CE projects. Something that can be seen in the Bräcke school project in the amount of areas where renovation and reinstallation of parts has naturally been brought up.

Regarding future CE processes the literature study requested a more present client role (Gorgolewski 2008 and Danckwardt, et al, 2019a), following the PM_Bräcke at LF has shown that the PM already follows the project from start to finish and have the possibility to be quite present within all parts. If a demand from LF was put on their PMs to take this new more present role, the change doesn't seem to be as big as it could have been expected. But not all processes are easily adapted. At the Bräcke school project the main focus of providing buildings for education stands in conflict with project planning, as the PM already views the execution plan of doing the new production first and the renovation later as problematic. This, as it makes the project more complex, is still necessary, as the evacuation of students and the school activities always are valued the highest. A requirement that will stay in the future and reduce the possibility for flexible projects that are needed for CE processes. The example clearly seen at the Bräcke school project, is that material that is to be demolished from the old building, and possibly could have been used in the new, can´t be used as the new building need to be completely finished before the next part starts to enable the education the go on with as low disturbance as possible.

Regarding the processes at LF a problematic area found is the lack of focus in the feasibility study. The feasibility study is presented as a phase where the PM is able to include the assessments she/he sees necessary, providing a good setting for inclusion of future CE processes. But it is also described as problematic as no investment decision is given yet, and the actual realization of the project is unsure. As a result proper assessments are not always performed to keep costs down. As the PM has the possibility to question these decisions and promote other solutions, a recommendation from a feasibility study can be changed. But an uninterested PM who doesn't have a CE focus might not put in the extra effort to do that, as no pressure to do so is enforced by LF.

In the project there are no routines for the PM to document when reuse questions have been raised, and it is up to the PM to bring that focus if she/he wants to. Similarly, the role model areas using the outdoor storage, lack direct responsibility of keeping track of what is being stored at the site, and equipment and material is said to be easily forgotten. Connected to this the process of making a material/reuse inventory to identify material in the whole building is not implemented yet, but something that LF is working on implementing in the future.

When conflicts between requirements and solutions arise, the PM has to contact the area specific experts if she/he wants to be able to include the solution, similarly if solutions could exceed the budget, higher managerial levels need to be contacted. In the literature review, Danckwardt et al. (2019a) found that LFs TKA currently is hindering CE solutions and processes. If a PM wants to include more CE solutions in their project deviations will therefore be common until TKA is updated, affecting the work of the PM.

Economy is probably the area where this will be a difficult topic. As the budget comes from the schools and initially from politicians. It isn't something a PM can easily affect. On a project level the PM already explains it as quite complex, giving the example of the divided project budget at the Bräcke school project, something that probably will get more complex if material is to be exchanged between projects in the future.

Though this project reuse ideas and CE thoughts have been seen as an interesting possible future processed by the PM_Bräcke who describes herself/himself as interested in sustainability, and that she/he conscience-wise, sees a large responsibility. A PM with less personal interest that doesn't feel the responsibility could instead to choose to not include CE processes. The freedom to plan and execute projects in their own way can possibly become a problem in the future if LF wants to promote CE processes, as the freedom to include steps in the projects also is a freedom to exclude. Finding conflict where other requirements can be promoted over CE requirement will probably stay a reality, and a situation connected to the role of the PM at LF that will have to be solved. The interest and aim to transition towards a more circular process is present at LF. Efforts such as participating in research studies, innovation project such as Hoppet, as well as the work to develop routine for a material inventory all portray the image that the transition has begun. Yet the focus doesn't seem to have reached even the most interested of PMs, and some more coordination and implementation will be needed to spread the focus within the project organization.

A material inventory is a crucial step for a circular focus to be implemented at LF. As mentioned above, a material inventory is currently lacking. PM_Bräcke sees no problem in that the feasibility study takes longer time, which will be a consequence of implementing a material inventory according to Contractor 1. In that part of the project, time is not as critical as in later phases such as design and above all production. If a material inventory were to be

included in the feasibility study, it would be added before there is an investment decision, which means that if the project does not get realized, these inventories have been made unnecessarily and an extra cost has arisen for LF. The future material inventory is planned to take place after an investment decision has been given, the PM_Bräcke advocates that it instead should be performed before the investment decision. This indicates that the PMs opinion has not been included in future plans for a material inventory, something that might become a conflict.

Regarding how to perform an inventory, the two role model areas kitchen and the work of the antiquarian, are compared. When describing the process connected to kitchen retrieving equipment in the buildings, no resistance or conflict is portrayed. The process is presented as simple and routine, not affecting the project in any way, and not a demanding task for the PM. On the other hand the antiquarian is not met in the same way by the PM_Bräcke. The PM_Bräcke instead described the inclusion of the antiquarian as somewhat problematic, having a role that makes hard requirements. Claiming that the requirements might stand in conflict with the use of the school and the demands of the client. The PM's response towards the kitchen´s approach of inventory is seen as more positive than the approach towards the antiquarian. This indicates that the PM_Bräcke´s response towards a future material inventory can span between either of these two. Reasons for the different responses could be that the kitchen inventory is made by LF area specific experts, it is an established internal routine and the PM knows which area they will assess. While the antiquarian is an external role, assessing the entire building, and not a routine in all LFs projects. The decision of the antiquarian is also a requirement, which is hard for the PM to affect.

It appears in the results that the PM_Bräcke is not fond of the idea that someone should come from the outside and decide what in the project should be reused and not. The PM_Bräcke believes that those who are involved in projects should be the one making the decisions because they are the ones with the most knowledge about the project. However, the PM_Bräcke thinks that hard requirements will lead to the most reuse within LF, but that the work climate can be negatively affected. The conflict could possibly be reduced by making sure that the PM trusts the role making the inventory, and that the role understands and has an insight in the project process. Further contradicted opinions arise whether internal or external actors would be responsible for the future material inventory. On an organizational level the future plans for material inventory is to use internal resources, but the PM prefers to use consultants with a combination of inhouse competencies. If LF uses inhouse competencies for the future plans, there is a concern that the internal resources will not have the time to do a proper inventory due to the large project portfolio. Further showing the lack of PM involvement in the creation of the material inventory plan.

The PM_Bräcke believes that construction parts are easier to reuse than installation parts. Consultant 1 claims that reusing installation parts is not problematic and that both knowledge and a will exist. Here, the collaboration and communication between the actors involved in the construction industry are important and could possibly overcome barriers connected to knowledge. LF has a well developed knowledge exchange internally which indicates that the organization structure can take advantage of increased collaboration in projects when implementing CE, by spreading the knowledge gained from the project collaborations throughout the LF organization. Architect 1 and Consultant 2 both states that the project process needs to include more collaborative measures, both between the project phases and between different projects. Including more collaboration will probably demand more time, communication and coordination within and between projects, additional steps and roles to

manage by the PM. The request of increased collaboration is supported by the literature, which states that collaboration simplifies the material exchange as well as problem solving, along with coordinating solutions (Hart et al., 2019; Minunno et al., 2018).

In order to enable a material exchange at LF after a material inventory has been implemented and performed, collaboration between projects must be in place. As there is no role today at LF, that coordinates this process the responsibility to contact other projects would be on the PM. Something that the PM_Bräcke thinks would demand both energy and time, seemingly unengaged to do so. The PM_Bräcke describes that a support function would be essential for increasing the amount of collaboration, and for coordination of reuse between projects at LF. It would facilitate the PM's work if the support function had an overall knowledge and task to inform PMs. A role that would coordinate the information exchange and connect projects with each other. As the PM currently delegates a lot to the design manager and construction manager, it is important that everyone in the project knows "the rules of the game" on what CE is according to LF. This means that the PM has a great responsibility for communication as the PM is the bridge between the project and LF's internal knowledge. Even if there would be a support function or coordinating role connected to CE within LF, it would still be the PM's responsibility to make sure the project participants are informed and understand the aim.

8.1 Barriers and enablers regarding circular processes connected to project manager and structure at LF

Building technology
Looking at the LF organization it will not be a task for the PM to decide if material is to be reused, when hazardous material is identified in a building. What will be a task for the PM is the planning for the assessments, both the current assessment to identify hazardous material, as well as when to include the new assessment to identify reusable material. As all respondents in the interview study said they wanted to get in early. The assessments of hazardous material must be performed ahead of time before the decision of involving new actors can be made, as hazardous material will be a make it or break it moment for reuse. The hazardous material present within buildings has made some buildings entirely un reusable while others have components that need to be identified (Minunno et al., 2018; Chini & Bruening, 2003; Finch et al., 2021). Making this a lasting barrier and an important step for CE projects. Showing that Resulting in more pressure being put on the PM regarding the project planning.

As found, sturdy fixings of material have been a focus at LF buildings, and fixings damaging material when dismantled will probably be common in most LF projects. As material is mounted to withstand the care of children. As was found through the barriers, the traditional way of building and fixating material will be making the dismantling of material difficult (Chini & Bruening 2003). Depending on the level of difficulty to dismantle the material this can affect the PM, if dismantling gets too complex for the contractor or if the cost of the procedure affects the budget. Knowing that material might get damaged when dismantling to a higher extent within LF buildings than other buildings might also affect the possibility to distribute the material when dismantled. The fittings add an additional uncertainty regarding what the quality of the material will be when dismantled. Something that will be affecting the PM both when trying to plan for distributing, as well as locating material for projects. The focus of un-dismantlable materials during the usage of the building will withstand, as the buildings will continue to be used by children. Changing the focus to easily dismantlable material, something that is recommended by the literature, that still lasts the impact of children

will be difficult for LF. This problem will probably have to be handled by LF area specific experts, who have to specify in the TKA what fixing should be used. As the level of detail of discussing fixings is not a part of the PMs task currently. Having a centralized plan at LF would make sure fixings in most new buildings follow the same standard. Something that can be seen as an enabler for the future as the same solutions will be found in most buildings.

Politics

Laws and recommendations connected to them is something that a PM has to follow and work according to. Changing these laws is not a task that a PMs can do in their daily work. Current law and regulations hindering the inclusion of certain reused components and complicates the use of others. That is a barrier that the PM will, according to Danckwardt et al. (2019a) and Ghaffar et al. (2020) encounter when working with CE and reused materials in the current setting. On the other hand, Architect 1 viewed laws and regulations as a way for the governments to support projects and PMs, by enforcing circular requirements and simplifying public procurement when working with CE, something that can be strengthened in the literature. These steps could simplify for the PM but could also affect the task of the PM negatively if they were realized, as fulfilling the requirements would be an additional responsibility of the PM. Something that could be a demanding task if a legal requirement would be implemented in the current linear setting.

Something that the external parties highlight as an enabler is financial incentives. Assuming that financial incentives in the construction sector are an important part of the system's transition towards a CE, an enabler that the literature also promotes. Creating the economic incentive requires political determination, and that CE is put high on the agenda. This can be illustrated by a 'carrot and a stick approach', a carrot could be to finance demonstration projects with public funding such as Hoppet. A stick could be to new tax structures and fees mentioned by Nordby (2019), to force the industry towards system transition towards a CE.

Standard

Similarly to law and regulations a PM is affected by an industry standard but it's hard to change them. A standard gives a PM a toolbox that she/he can work according to. If a PM wants to implement CE in a project, currently the lack of standards will create a situation where the PM has to work without the toolbox. One area where working with CE will be difficult according to Architect 1, is the complexity of getting reused material certified with a CE marking and registered in the BVB. BVB registration is also a requirement in the TKA forcing PMs to request deviations if she/he wants to use unregistered materials. This leads to an extra step in communication and will probably be more time-consuming because the PM has to contact area specific experts and wait for their decisions. According to Danckwardt et al. (2019a) LF currently lacks a CE focus in TKA, indicating that deviations will be needed more frequently, this as well as the certification process will increase the complexity and demand for planning in the project.

There is no common definition used for CE in the construction industry, which is a problem when developing a common industry standard presented in the result. Assuming that developing a common standard opens up for two things, one thing is that different competitors can work in the same market because they have the same rules of the game. The second thing is that a common standard makes it easier for the PM and the PM has something to relate to. Working according to a standard can simplify the work of the PM, implementing a CE focus might clash with the standard creating a conflict for the PM. The conflict of focusing on CE or

using the recommended and well-established methods, might be a complex issue for the PM to solve since she/he has to deviate from an established routine.

Process

The external actors describe CE projects and processes as demanding more flexibility within the project group. Flexibility that has to be enabled by the client through the PM. The need for flexibility can be connected to the literature that says that architects and consultants in the design phase will need to design more flexible solutions (Gorgolewski, 2008; Danckwardt et al., 2019b). To enable flexibility in the design team, more time will be needed in the design phase. Affecting the schedule of the project that the PM manage, who also needs to support the design team with the requirements to make sure the flexible solutions still stays within the boundaries of the project. Support and a clear aim provided by the LF organization is something that possibly could simplify these demands. Developing the new more present client role recommended by Gorgolewski (2008) and Danckwardt et al. (2019a). The supporting coordination role previously mentioned could also be a way to reduce the demand on the PM in response to the increasing flexibility. To do so the role cannot just be a coordination role between projects, but has to be present within the project as well. A support that could be compared to the installation coordinator at LF, that could be responsible for all questions regarding CE within the project. This role is also recommended by Gorgolewski (2008) in the literature. On the other hand, LF tries to build a strong internal network of specialists surrounding the PM. At the Bräcke school project the PM has the support of both the assistant PM, the design manager as well as the area specific experts. If they have an implemented CE focus the support that might be enough to handle the new processes.

In circular projects much focus and work will have to be done in the early stages according to Consultant 2, something that is strengthened by Ghaffar et al. (2020). A phase that will require more presence of the PM and increased project planning. All respondents in the external actor interviews stated that they want to get into the project earlier than in traditional projects. Changing the current processes for the PM who will have more actors and contracts to work with in a phase where a lot of the project is quite undecided. In addition to a more present PM and an additional supporting role, Consultant 2 also suggests that a strong business case form LF could be an aid to the PM in these areas. Supporting the PM in questions regarding economy and adding CE as a clear focus within the project from the LF organization. Something that is also raised as an important enabler by Adams et al. (2017) in the literature.

Concluding the results new pressures and demands will be put on the PM when adapting the project process to CE. The PM role at LF is today already quite flexible, and the PM can include the steps she/he thinks are suitable within the project boundaries, and LF has support functions in many areas. For PMs that already work in flexible ways and that are interested in incorporating CE in their projects, this might be an enabler for CE processes. The lack of demands and standardized processes on the other hand can produce a gap between flexible PMs and ones that have developed a standardized project process on their own, with low interest in including new steps. Something might become a problem for LF when incorporating CE in the future.

Engagement

In the external actors interviews Consultant 1, 2 and Contractor 1 all mention that client requirements and requests are what is needed to get the CE engagement going, and that the lack of engagement among the clients are what is missing. Connecting this to the PM at LF, the role gets a bit squeezed between the project stakeholders. LF can develop their own

requirements and goals, and the PM can use them to try to encourage the project participants by including CE requirements to spread engagement in the project group. At the same time LF is not the end client, the end users and the politicians also need to be engaged and request CE for it to be included in the project budget. The lack of engagement can come from all around the PM (Hart et al., 2019), and the PM can be put in a situation where neither the client nor the project participants are requesting CE. Even the requirements put on the project from the internal organization can be a problem as in the case with TKA. If no requirement to work with CE is put on the PM, it will only be up to the individual interest to include and promote it in projects. A method that probably won't be that successful.

Regarding engaging stakeholders, the PM at LF does not have the task of promoting reused materials to end users, and the client relationship differs from private actors as the request comes from political decisions and not a supply and demand case. Contractor 2 mentions the end-users opinion of reused materials as a barrier, something that can be found in the literature as well. The end users have an image of reused materials as being old, stale or dirty (Mahpour, 2018). Client 1 mentioned that this opinion can be tackled by showing the end user how nice the incorporation of reuse can be. By including reuse in the LF project in a nice looking and well functioning way, the projects could possibly be used by LF to promote CE to the politicians and end users. A way for the PM to support LF in tackling this barrier.

The question of engagement by all parts seems to be easily blamed on someone else to reduce their own responsibility. When reading the results the fact that most actors blame each other regarding engagement can be found. Consultant 1, and 2 and Contractor 1 and 2 all speak of the need for clients to request CE. On the other hand, the literature speaks about design teams and contractors unwilling to engage, additional project cost and warranty issues affecting the engagement of the client, as well as the lack of engagement among urban management and supply chain actors not being interested. Possibly making the statement that the PM and client should be the ones spreading the engagement and increasing their request for CE, less of a solution and more of a way to reduce their own responsibility.

Knowledge

It is not the PM's responsibility to educate the industry, but it is important that CE connected knowledge is present within the project to implement CE. As mentioned above, there is no common definition in the industry, which means that everyone in the project "does not speak the same language" (Danckwardt et al., 2019a). What one considers to be circular may not be the same image as another actor has. It is important for the LF to set up the rules of what is CE. The PM needs to communicate and highlight what knowledge is needed in a project. The PM is also responsible to make sure everyone works within the project boundaries. Since projects involve many different actors, it is important that everyone has a common image of what CE is at LF. In a circular value chain, knowledge is needed at all levels, and the chain will never be stronger than the weakest link. In response to these the PM can also identify areas where knowledge is missing, something that could aid LF in distributing knowledge in the future.

Consultant 1 describes that a certain type of knowledge has difficulty fitting into a linear system, which means that knowledge is disappearing. Consultant 1 gives an example of restoration of windows, a trade that is disappearing in the Swedish industry. If knowledge of how to restore materials is deficient with few actors on the market, it affects PM's ability for these alternatives. In general, the value of competence to extend the lifetime of products and systems will have an increased value in a CE. This is a revalorization of traditional trade, where competences that had a hard time fitting into a linear economy, get new possibilities in a CE.

Economy, time, and uncertainties

The PM's responsibility is to fulfill the project's goals addressing time, quality and economy. As the literature study showed, all of these areas can and probably will be affected in one way or another when a more circular focus is adapted. This can produce a conflict for the PM as focusing on CE could reduce the result of their work in regard to these goals, and PMs in the future might need more guidance from their superiors on how to work around this problem. The PM needs to prepare for extra costs in the budget when implementing CE in projects. The uncertainty connected to the economy is something that is directly linked to the task of the PM. Another dimension of complexity regarding the economy, is that the PM can prepare for extra costs in a project but it is not the PM or LF, who makes the investment decision. The PM can suggest a higher budget to prepare for the economic uncertainties in a feasibility study, but it is the municipality of Gothenburg city who is in charge of the investment decision, this indicates that the municipality has a role to play and Danckwardt et al. (2019a) shows that there are clear ambitions at the municipal level. To start the system transition towards CE the PM can suggest small steps toward CE. To reduce the economic impact Hart et al. (2019) recommends taking small steps to include reuse and CE focus within the project. By focusing on areas where the price difference between virgin and reused material is smaller, instead of focusing on the entire project being circular from the start. Another small step could be to stop focusing on adding new material, and instead focus on what material can be saved within the building. For example, by relocating a door within the building instead of buying a new one.

Connecting uncertainties to processes Contractor 1 describes that if you are to make an in-depth material inventory in a project, it will be more time-consuming. Making it difficult to justify the inclusion of the inventory in projects. This affects the PM who has to handle a more flexible schedule and increased uncertainties within the project that needs to be taken into account in LF´s processes for a CE project. Connected to uncertainty, time is also something that is strongly linked to PM. Chini and Bruening (2003) mention that time is equal to costs, which means that what affects time also affects cost. The uncertainty of the project participants needs to be handled by the PM so that it does not create problems in the project organization. To tackle uncertainties problem Consultant 3 mentions that the top management need to prioritize CE and support the PM in these questions, reducing possible conflicts for the PM.

How the project timeline gets affected by the findings and in what phases of the project is presented in Figure 9.

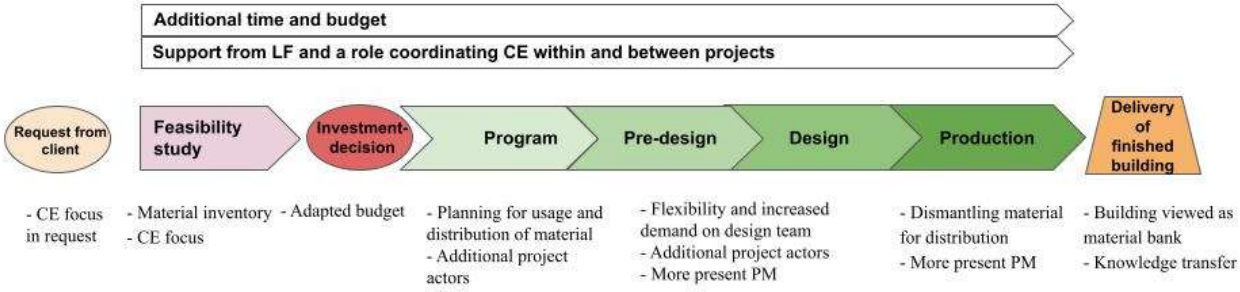

Figure 9 - Project timeline in a CE project

9 Conclusion and recommendation

This chapter presents the conclusion and recommendations based on the analysis and discussion in the previous chapter and suggestions for future research.

Currently, a CE focus means that the PM must deviate from an established routine, new processes such as a material inventory must be added to the PM's project as an extra checkpoint. The PM is measured on time, economy, and quality, but as the project is likely to be both more expensive and more time-consuming, it is important that the PM is given more guidance from their superiors on how to work around this problem. A recommendation is that the PM should be measured on other factors that include a CE focus, such as the amount of reuse in a project. The PM needs to be more present in the projects before a routine is in place, as there will be a lot of uncertainty factors. Furthermore, to start exchanging material between internal LF projects a collaboration between projects need to be in place.

To support the PM, a CE coordinating role is essential, to coordinate project collaborations as well as to be responsible for the questions and processes within the project. There are different opinions regarding using an external or internal role, but either way it is essential that the PM trusts the role and that they work together towards a mutual goal. Furthermore, a CE standard would be a toolbox for the PM, but also a way for LF to enforce CE processes on unengaged PM´s and project participants.

The CE project process will be more complex, as new demands and requirements need to be taken into account. The schedule and the budget will be affected and industry actors will be present in more ways than today. Managing the additional complexities, as the current complexities remain, highlights the importance of planning. The planning and the CE focus need to permeate the entire project process and the LF organization. To implement CE will be a challenging task for the PM at LF, but every project can do something. By adapting the project process in areas that seem less demanding, and incorporating some of the steps into the routine, the demanding tasks for the PM will be reduced. The role of the PM is an important enabler for a CE, and reducing the complexities for the PM is an essential factor for the transition toward a CE in the construction industry.

9.1 Future research

The reference project investigated in this thesis did not have a CE focus, to validate the findings an additional case study following a PM in a circular project could be performed. Logistics was a limitation in this thesis but a suggestion for future research is to investigate how the PM would be affected by logistics when working with reused material. Furthermore, the design for reuse part of CE, and the effect on the project process, of including it in a project is something that we recommend for future research. Finally, the benefits of having a standard as a support for the PM is highlighted in this study. What this standard should include to aid the PM in the best way should be further researched.

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Appendix 1

Prolog
- Inled med att presentera vår forskningsfråga och vårt intresse för området.
- Fråga om det går bra att spela in intervjun.
- Fråga om anonymitet önskas eller om det går bra att nämna organisationen/personnamn.
- Fråga om intervjupersonens ålder, utbildning, yrkesbakgrund, nuvarande roll och anknytning till organisationen.

Bakgrund
Beskrivning av aim samt en introduktion till arbetet

Introduktion

Er definition av cirkulär ekonomi (CE)?
- *(riv(reno), design för dismont, återbruk i nybygg) (miljö/trend)*

Ert erbjudande
Vilka roller inom CE arbete har ni?
- Uppkommer det några nya roller när man arbetar i ett CE projekt?

I vilka skeden kommer ni in idag?
När hade ni velat komma in för att utöka möjligheterna

Finns det någon upphandlingsform som är fördelaktigt för CE enligt dig?

Skillnader
Skiljer sig arbetsgången gentemot ett traditionellt projekt?

Vad skulle du säga är det största hindret för CE som ni stöter på.

Ser du några lösningar till detta, eller hur CE kan lösa något annat problem i projekt.

Arbete i CE projekt
Vad anser du är det viktigaste steget för att implementera CE i byggsektorn?

Är det något speciellt i upphandlingskraven/uppdragsbeskrivningen som gynnar CE?

Epilog
1. Finns det andra personer på avdelningen som ni rekommenderar att vi lämpligen bör intervjua gällande dessa frågeställningar?
2. Har ni något annat som ni vill tillägga?
3. Går det bra att vi kontaktar er om vi skulle ha någon ytterligare fråga?

Appendix 2

Prolog

- Hur länge har du jobbar som PM på LF?
- Vad är din bakgrund?

- Får vi nämna ditt namn i vårt arbete eller vill du vara anonym?

I alla svar utgå från Bräcke, men du får självklart utveckla med generella svar också.

- I vilket steg kommer du som projektledare in i projektet?
- Vad är gjort i/hur ser projektet ut då?
- Hur mycket skiljer det sig åt när det är som på Bräckeskolan, är en renovering också, och när det är ett helt nyprojekt? Är det skillnad i vad som är gjort innan
- Som beställarens projektledare, hur ser organisationen runt dig ut, hur kommunicerar du med externa aktörer (projektledning/produktion) i projektet?
- är dom rollerna interna eller externa? Byggledaren och biträdande?
- Ansvarsfördelning - vad är ditt primära ansvar
- Hur ser fördelningen mellan interna och externa roller ut i LF projekt?
- Hur sätts budgeten och vems pengar är det?
- Ja vi tänkte väl mer från vilken förvaltningsbudget
- Hur tight brukar budgeten vara? Är inställningen "använda allt" eller än budgeten alltid knaper?
- I bräcke skolan då som är samma fastighet med två projekt, delas det då upp helt och hållet mellan två budgetar och två projekt, eftersom det är en renovering och en utbyggnad. Eller är det. Hur sattes den?
- men fördelningen har redan sett/ sker nu innan projekten börjar, det är inte så att man slår ihop en klumpsumma i slutet?
- Hur sätts tidsplanen, och vilka intressenter ställer krav på denna?
- Och intressenter ex skolans verksamhet?
- Anser du att stödfunktionerna är tillräckliga, finns all kunskap inhouse? Hur är tilliten till stödfunktionerna?
- Hur är bemötandet från stödfunktionerna när man kommer med en ny idé (där man inte vill arbete enligt TKA),
- Hur följs krav i projekten upp? det är på dig att kraven följs men hur kollar man på att miljömål, TKA, budget, tid följs upp..
- Vilken information lämnas över till förvaltaren efter färdigt projekt.
- Information om projektet, vart sparas det?
- Hur är det med ritningar, är dom digitala eller är det pappersritningar?
- Hur samarbetar projektledare på LF med varandra?
- Hur sitter ni på kontoret i vanliga fall?
- Motivation till viljan att arbete med samverkan? Som vi sett att det blir i bräcke.
- hur kommer det sig att man inte får använda sig av samverkan?

Vi ser ju på projektstyr att det är ganska mycket som är utredningar och sånt som är gjort innan och även ritningar och så. Är det mycket mer ni kommer göra eller blir det entreprenören som får göra resten av projekteringen så att säga?

- I önskat läge hade det vart att börja med renoveringen och sen kört nyproduktionen?
- Hur vanligt är det att man bygger till en helt ny byggnad på en befintlig skola, och i hur många fall är det att man bygger en helt ny skola på en annan tomt så att säga?
- Så man vill gärna samla och får bra organisation och allt för samma plats för barnen
- Hur följs projektledarens arbete upp generellt på LF, vidare utbildning, stöd, lyckade projekt. Alltså hur följs ditt arbete upp?

Nyproduktion projektering

- Kan LF ställa egna krav på designen av byggnaden (långvarighet, lätt att anpassa, lätt att renovera/demontera)
- Är det så ni skulle säga att ni framtidssäkrar byggnaderna ni bygger?

Nyproduktion produktion

- Hur sätts den projektspecifika miljöplanen?
- Om man går in på detaljnivå gällande material och miljö, är projektledaren någonsin med i miljöval eller är det mer det som står i miljö planen?
- Är du inblandad i inköp av material och installationer eller är det entreprenören?
- Är frågor om infästningsmetoder något nivå som projektledaren någonsin skulle hamna på eller är det hos antingen i tka eller hos entreprenören?
- Garantier för återbrukat material ni sätter in i en byggnad? både framför allt nya material som ni jobbar med nu men även, finns det nån diskussion vad som skulle. Hur det funkar med garantier för, till exempel återbrukade produkter. Vem håller i garantin just nu
- Vem ansvarar hos LF efter färdigt projekt, under garantitiden?
- Upphandling- är det en färdig mall, eller är det projektspecifikt, upphandlingskrav och så ser ut
- Hur mycket skiljer sig samverkan från en total som den väll ändå bygger på

Renovering

- Hur bedöms skicket på material och installationer idag, vilka inspektioner görs?
- I en sån underhålls eller skicks bedömning sätts det några interna Garantier ?
- Har du en dialog med fastighetsförvaltaren innan planerad renovering eller rivningsarbete sker? Information vilka åtgärder/renoveringar som har gjorts i närtid.
- Data på vad som har renoverats i nutid finns lagrat hos er så ni kan kolla det?
- Är det du som handlar upp rivningsentreprenad, eller är det entreprenören som gör det?
- Vad gör man idag vid den renovering med material som är återbrukbart i samma byggnad? Finns det någon process för det idag? eller ser man bara att det som behöver plockas ut det plockas ut?

Appendix 3

Intervju

- Kan du beskriva Bräckeskolan projektet
- Hur det projekt organisationen ut
- Var befinner ni er just nu
- Vad har gjorts tidigare

Detaljfrågor

- Hur kommer det sig att projektet är uppdelat?
- Hur kommer det sig att ni inte börjar med renoveringen?
- Vilka upphandlingsformer planerar ni att använda?
- (varför)

- Vad innebär bevarande kravet?
- Finns det nått cirkulärt fokus i projektet?

- Är det ett rutinprojekt för LF?

Appendix 4

Prolog

- I vilket skede befinner sig bräckeskolan idag? Vi blev något osäkra när miljöinventeringen genomfördes först nu, gjordes det en även i förstudien?
- I tidplanen på projektstyr finns miljöinventering mm, med både i förstudie och program, hur skiljer sig dessa?

Intervju

Vi har valt tre olika områden som vi kommer fokusera på i vårt examensarbete:

- Processer som redan är cirkulära på LF kopplat till renoveringsprojekt
- Steg i förstudien och program fasen kopplat till återbrukat material i renoveringsprojekt
- Samarbete mellan projekt och projektledare för att öka cirkulära material utbyten inom LF.

I alla frågor utgår vi från projektet och situationen på Bräcke.

Processer som redan är cirkulära på LF kopplat till renoveringsprojekt

- Kan du nämna någon process eller något moment som du anser är cirkulärt på Bräckeskolan idag? (för att få bekräftat att dom inte ser detta som cirkulärt, något som kommer framöver?)

- Finns det områden där återbruk alltid/aldrig undersöks/kommer upp?
- Ex. storkök hämtar saker som framgick från mötet med miljö.
- Finns det andra områden där bevarande/återinstallation kommit upp på Bräcke, finns det områden som tydligt förespråkar att riva och bygga nytt ex. inneklimat.
  (Ställ frågorna uppdelat)

Kommande frågor berör hur kommunikationen ser ut när information gällande återbrukbarhet kommer fram :

- Vad gör du idag när någon i projektet föreslår att spara eller renovera material, (ex storkök, radiatorer, antikvariska utredningen)
- Finns det en rutin?
- När diskussionen kommer upp, hur noga utreds till exempel åter-installationen av radiatorer idag, hur ser processen ut att välja mellan att behålla eller byta ut?Är det du som tar beslutet eller ligger det på någon annan
- På vilket sätt styr ekonomin och hur noggrant utreds det?

- Sammanställer du/någon informationen om vad som kan bevaras idag

(ställ följdfråga här beroende på vad hon svarar)

- Vi har förstått att storkök är ett föredöme här, när dom kommer in och “tar hand om” utrustningen. Hur ser din roll ut kopplad till deras uppdrag?
  (är det bara nått man måste boka, eller ger du eller någon annan information till storkök om potentialen innan dom kommer)

- (Bräcke) När förvaltaren efterfrågade en renovering, var uppdraget att fixa och byta ut så mycket som möjligt när man ändå är inne i byggnaden (som asbest-frågan) eller vill man göra så lite som möjligt för att minska projektets storlek och kostnad?
- (vem ville riva/ total renovera)
- När utredningar i projektet visar att renoveringen skulle kunna beröra fler moment, Asbest i fogar som egentligen inte skulle berörts, vem tar beslutet om det ska inkluderas samt hur är inställningen till att lägga in extra moment.

- Finns det en trend/vana eller beror det på förvaltaren/byggnadens skick?
- Finns det någon sakkunnig (avdelning) i projektet i den här delen som förespråkar motsatsen som du måste ta ställning till (bevarande kravet/inneklimat), hur tas det beslutet, på vilka grunder
- vilka avdelningar förespråkar att byta ut och sätta in nytt och vilka förespråkar varsam renovering.

- Om du i projektet fick ett krav på dig att sammanställa/ta vara på allt ni redan gör som kan kopplas till cirkulära processer, vet du i så fall hur du skulle göra detta?
- hur skulle det sammanställas
- Vilket stöd skulle du behöva
- Skulle det hamna på dig, eller skulle du delegera det till någon annan.
- Om kravet istället skulle vara att redovisa allt ni inte kan återbruka, tror du det hade varit mer gynnsamt för att arbeta med återbruk

- Detta har vi har snappat upp i projektet som förslag på att bevara/återmontera:
- *Radiatorerna, - frida själv*
- *Armaturen - Behovsbeskrivning*
- *Inredning (fönsterbräden) - Antikvarisk*
- *Dom nyaste fönsterna - Miljöinventering*
- *Fönster - Uppdraget*
- *Installationer utan att störa byggnaden. - Inneklimat*
- *Renovera istället för att riva - Beslut förstudie*
- *Storkök - Miljöinventeringen*

- Är det en vanlig mängd, eller sticker det här projektet ut i antalet förslag på bevarande?
- Finns det fler områden som vi har missat?
- Var det uteslutande besvarande kravet som påverkade beslutet att renovera istället för att riva?

- I byggnader med bevarandekrav, där man ändå måste renovera mycket.
- Läggs det mer fokus på att behålla material som nämnts som “orginal detalj/tidstypisk” i utredningen, än material i byggnader utan kulturellt värde?

- Mer fokus på att bevara en tidstypisk detalj vs kakelplattor
- Ex fönsterbrädorna som beskrevs som fina, om väggen och fönstret måste rivas, försöker man sätta tillbaka fönsterbrädorna någon annanstans eller är det bara mer en generell kommentera om byggnaden

- Gör bevarande kravet att ni fokuserar mer på att bevara istället för riva, eller påverkar det bara besultet i förstudien? (Genomsyrar det hela processen?)
- Hur påverkar ett bevarande krav de olika skedena i projektet?

- Hur ser du som projektledare på ditt ansvar gällande cirkulära processer idag?

Samarbete mellan projekt och projektledare för att öka cirkulära materialutbyten inom LF.

- Hur ser samarbetet mellan projekt och projektledare ut idag?
- Om ett projekt köpte material från ett annat vilken av projektet skulle betala samtlig kostnad för det?
- vad tror du hade blivit den svåraste biten ekonomiskt?
- Angelica har föreslagit att projektet som "köper" materialet betalar demonteringen och samtliga kostnader, vilket blir inköpskostnad.
- På vilket sätt skulle det påverka ditt arbete med budget?
- Hur fungerade kommunikation, och ekonomin i projektet där ni återbrukade dörrar?
- Vad är det sista som monteras i nybyggnationen på bräcke? Är det kopplat till det som rivs först i renoveringen.
- Vilka funktioner som finns i den gamla byggnaden ska bort och ersättas i den nya?
- Hade det varit möjligt att överlappa projekten på bräcke? (för och nackdelar)

Vårt hypotetiska scenario där det fungerar

I ett påhittat scenario på bräckeskolan där projekten överlappar och ett antal innerdörrar som inte kommer behövas efter renoveringen, efterfrågas i nyproduktionen (utan mellanlagring, uteslut tidsplan och kvalitetsbedömning)

- Beskriv vad du som projektledare i bräcke projektet hade behövt göra:
- När hade du behövt ha information och vilken i de olika projekten?
- Hur säkerställer (håller koll på) du mängden material som kan flyttas mellan projekten
- När i respektive projektet skulle man behöva fokusera på detta? (planera för demontering, mängdning, projektering, montage, inköp)
- När informeras entreprenörerna och på vilket sätt,
- Kan en aktör handlas upp både för att demontera och montera eller krävs överlämning mellan projekten?
- Hur hade detta påverkat ditt jobb i projektet, i det olika skedena. (tid delaktighet)
- Hade du som projektledare fått sköta detta eller hade någon annan resurs gjort det dagliga arbetet?
- Om du endast hade en av dessa roller. Vilken kommunikation hade du behövt ha med det andra projektet och i vilka skeden, berätta ur båda synvinklarna
- Vilket stöd från LF tror du du skulle behöva i detta
- Vilka hinder ser du?

Samarbete mellan projektledare på LF

- Vad tror du skulle krävas, gällande samarbete, för att projektledaren på LF skulle ha ett material utbyte mellan projekten? (insyn, forum, ansvarig)

- Vad tror du att det hade blivit för konsekvens för dig som projektledare om det skulle bli ett ökat samarbete mellan projekt för att återbruka material?

Steg i förstudien och program fasen kopplat till återbrukat material i renoveringsprojekt

- Vad skulle du behöva göra i förstudiearbete och programskedet för att identifiera direkt återbrukbart material?
- Vilka stöd kring hade behövts finnas på plats?
- Vad tror du hade behövt vara på plats i förstudie arbetet och programskedet för att identifiera direkt återbrukat material?
- Hur beställs och bokas inventeringar?
- Vilket ansvar har du i vad som undersöks?
- I utredningar/inventeringar som görs idag, tar du beslut om hur resultatet ska användas eller är det rutiner/standarder/krav som bestämmer vad man gör efter en inventering? (typ av vent, asbest, kök)
- Vad hade det blivit för konsekvens för dig som projektledare med en "extra checkpoint" det vill säga en materialinventering i ett projekt? (inställning, arbetsbörda, redan stressigt)
- **Vilket stöd hade du velat ha och varför?**
-

Här följer tre olika förslag på hur en material/återbruks inventering skulle kunna genomföras

- Material/återbruks inventering skulle ske på samma sätt som en miljöinventering (gällande beställning, kontakt, uppföljning)
- Att sakkunniga för respektive område på LF skulle ut och inventera det som rör dem.
- Återbruksinventering/materialinventering skulle läggas som ett steg in i de befintliga utredningar som idag görs i byggnaden (exempel, vent kollar över återbruk för ventilationen, vatten för vatten och miljö kanske för en övergripande)

- Hur ser du som projektledare på dessa upplägg ur din arbetssituation?
- Hur skulle det påverka ditt arbete och projektet (tid, upphandling, antal möten)?
- Vad tror du det hade blivit för konsekvens för dig som projektledare?
- Hur hanterar du att få information "från olika håll" till exempel?
- Hur tror du de olika förslagen hade påverkat budgeten?
- Har du något ytterligare förslag?
- Vi anser att material inventeringen skall va en av de sista utredningar man gör (i förstudien).
- När ser du den bästa tidpunkten för inventeringen kopplat till dagens rutin.
- Finns det något som måste göras innan och efter enligt dig?
-

Vi funderar lite på om en materialinventering ska in som obligatoriskt steg i alla projekt för att få in rutinen eller om den endast ska göras i projekt där tidigare utredningar (miljöinventeringen säget att allt är giftigt) visar att det finns potential.

- Ser du några för och nackdelar kopplade till dessa alternativ? (budget, få in vanan, tid)
- Hur ser vi till att material inventeringen inte blir som gröna tak, där kravet på utredning finns men det knappt utreds
- När en metod för material inventering finns på plats, (och det finns med i budgeten att återbruka) hade du velat få ta besluten gällande vad ni demonterar/återbrukar i det här projektet, eller hade du velat ha ett krav/beslut från en sakkunnig typ som på storkök.
- Vad hade resulterat till mest återbruk? (din insyn vs ett krav)

Appendix 5

Prolog
Uppföljning och förtydligande av tidigare svar

Intervju
Kan du beskriva din roll i projektets olika faser:

- Förstudie
- Program
- Projektering
- Produktion

Hur förändras din närvaro i projektets olika delar?

När i projektet är du mest aktiv, och när delegerar du ansvar till annan (specialist eller underordnad?

Vilka kompetenser måste PM ha och vad måste du vara kunnig inom

Vilka krav ligger på PM idag från LF, vilken närvaro, förståelse för hur många delar, vilken kunskapsdetaljnivå.

Hur kontrollerar du och arbetar du med de tre sakerna ni mäts på: Kvalité, ekonomi och tid? hålls LF pm uppdelade mellan typen av projekt, tex vissa jobbar bara med skolor, eller är det blandat, slumpartat, efter eget intresse.

Har projektledare på LF mer än ett projekt igång samtidigt?

Hur ser organisationen runt dig ut, vi vet att du har en biträdande, en projekteringsledare och en byggledare, men hur ser det ut uppåt? vem får budget frågorna (när det överskrids)och vem svarar du till?

Om hon inte nämnt det ge dessa frågor som exempel
De veckomöten som schemalades med projekteringsgruppen på uppstartsmötet vi var med på, är du deltagande i dessa?

Hur ser din kommunikation och insyn i projektet ut framöver, förutom att följa upp och förbereda dessa möten, vad gör du något ytterligare i projektet

Hur vanligt är det att PM går in och är både projekt och byggledare, du har nämnt att möjligheten finns.

- vad är det som påverkar möjligheten (projekt storlek, erfarenhet, tid)

Hur går upphandling av konsulter till? vad gör du i den processen, **i program och projektering framförallt**. (vi vet att det oftast är ramavtal, men hur går processen till

Konsulter- upphandling:
I tidsplanen finns tre upphandlingar med i programskedet, en för program, en för projektering och en för systemhandling, stämmer detta eller är det bara påminnelser ifall det behöver göras? vilka "områden" handlas upp i dom olika faserna.

De arbeten som gjorts tidigare (miljö, mark) ingår dom i den gruppen eller är det någon typ av förlängd förstudie.
Kommer dessa konsulter vara "samma" för program och projektering i hela projektet eller finns det någon ytterligare större omorganisation, förutom när entreprenaden kommer in

Utredningar av åter installation:
När diskussionen kommer upp, hur noga utreds till exempel åter-installationen av radiatorer idag, hur ser processen ut att välja mellan att behålla eller byta ut? Är det du som tar beslutet eller ligger det på någon annan?
Det är mer att lyfta frågan, håller materialet för en livscykel till JA eller NEJ. Kan man rusta upp det JA eller NEJ. Och även då kostnads perspektivet kontra livslängd.

Vi säger att konsulten säger att den klara en livscykel till och att det går att rusta upp, men att det kostar XX kr.

- Är det projektbudgeten som styr
- Kan du förtydliga vad du menade med kostnads perspektivet kontra livslängd? (förklara- är det följdfrågor)
- Hur mycket insyn har du i den processen? Gör du någon kontroll på hur konsulten har utrett detta?
-

Vi har uppfatta att du anser att det är lämpligare att kravställa återbruk på byggnation än vad det är på installationssidan? Stämmer vår uppfattning? Om ja, varför tror du det?

- I en nyproduktion skulle du se några problem med återbrukade installationsprodukter?

PMs möjlighet till påverkan:
Vid scenariot "jämna med marken", hur kan du som projektledare påverka att det istället blir en ombyggnation eller renovering?

- Brukar idén komma från uppdraget, eller är det i en förstudie idén föds om att jämna en byggnad med marken och bygga nytt?
- På vilka grunder bestämmer man att man "jämna med marken" i ett projekt?
    - Skick
    - Komplexitet?
    - Kostnad?
    - Inställning?

Asbest frågan. har du något att säga till om eller är det alltid att allt ska bort, även om det är placerat i en del som inte skulle inkluderas i projektet från början

Vi skulle även vilja förtydliga ett tidigare svar från dig.
Gällande en roll (lf eller konsult) kommer in och material inventerar och ställer hårda krav på vilket material som måste demonteras för att kunna återbrukas.

- Senast när vi frågade lät det som att du tyckte det skulle vara bättre om projektledaren fick ta det beslutet, stämmer det?
- Är det nån skillnad om kravet är att återmontera i samma projekt eller om det bara gäller vad som ska demonteras varsamt i en rivning/renovering.

Appendix 6

Vi skulle behöva en lite djupare introduktion än vad som står på hemsidan om LF´s organisation och olika avdelningar

- Vad är LF:s uppdrag/ansvar
- Beskrivning av organisation (LF), vilka olika roller och avdelningar har ni?
- Beskriva de olika sakkunniga, experter och stödfunktionerna på LF som är kopplad till projekt
-

I vilka faser granskar sakkunniga dokument och vilka dokument granskas och inom vilka områden? Ex. förfrågningsunderlaget, systemhandling, besiktning etc.

Vem är det som ger investerings beslutet efter förstudien? Dvs om projektet blir av eller inte.

- Vem betalar för förstudien om projektet inte blir av?

Vilka olika ämnesområden har ni ett fokus på återbruk idag ex. storkök.

- Hur jobbar dom med det här? Hur ser deras uppdrag ut?
- Finns det någon annan avdelning som jobbar liknande?
- Finns det någon avdelning som är sämre på det här?
- Beskriv de generella fokuset på LF

Beskrivning av den materialinventering som planeras, hur skulle den se ut?

- Vad skulle ingå i en sån materialinventering?
- Vem ska göra det?
- I vilket projekt skede ska den genomföras
- Tar ni hänsyn skicket på byggnaden?
- Hur går planerna kring logistik?
- vilka skick planerar ni att kolla (Direkt Återbrukbart, Upcycle/down cyle, återvinningsbart)?
- Vilken nivå (ytskikt, installationer, stomme, mm)?
- När tror ni att rutinen/funktionen är på plats
- Du får gärna beskriva vad ni jobbat med så detaljerat som möjligt.

Appendix 7

Prolog
Presentation av vårt exjobb

Skulle du kunna presentera hur lokalförvaltningen jobbar, för vilken avdelning du jobbar på samt din roll.

Projekt bräckeskolan – beskriv det allmänt, arbetet under våren,

Projektledarrollen på LF i allmänhet, rutin eller frihet(ansvar), uppdragsbeskrivning från vem, mm.

Projektstyr

Vilka utredningar ska alltid göras?
Vilket stöd erbjuder LF sina PM?
Hur samverkar projekt med varandra?
Stödjande dokument, vem bestämmer vilka dokument som ska vara där? Finns det andra dokument som ligger med där?
    Finns dessa samlade så vi kan granska dem?
Hur mycket gör ni internt och hur mycket köper ni in?
Hur följs krav upp.
TKA - hur behandlas det som står här?
Finns det andra rutiner vi borde va medvetna om.
pilot vs baybystep, vad tror du är bäst:

hur är bemötandet gällande CE internt?

Vad är ett cirkulärt projekt?

Vilka utredningar ska alltid göras?
    Finns dessa samlade så vi kan granska dem?
Hur samverkar projekt med varandra?

Undersök befintlig kvalité i uppdragen? Görs det eller ska det köpas in?

Om bräcke projektet
När man läser Behovsbeskrivningen, så får man en uppfattning att de fokuserar på allt som är dåligt med byggnaden, det enda som nämndes kopplat till återbruk eller vad man kan bevara är armaturen. Är det alltid de fokuset? Eller hur ser uppdraget ut? Är det att man ska undersöka vad som ska bytas ut?

Rumsbeskrivning skola - ytskikten för varje rum beskrivs tydligt. Ska detta följas till punkt och pricka? Hur ser det uppdraget ut till entreprenad

TKA -miljöplan - material ska vara registrerade i Byggvarubedömningen, är det något som går att göra med återbruk idag, vad ni vet?

- det finns tre miljöplaner där "resurshushållning" ser olika ut i alla. vet du varför det ser ut så?

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