

**CONSTRAINING AND ENABLING FACTORS THAT
INFLUENCE CORE PRACTICES EMBEDDED WITHIN THE
SUPPLY PROCESSES OF CIRCULAR BUILDING HUBS;
A SOCIAL PRACTICE THEORY APPROACH.**



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I. PREFACE

Greetings, esteemed reader!

Welcome to the culmination of my academic journey: my master thesis, the magnum opus of labor and passion crafted with numerous thoughts, and more thoughts, some conversations, writings, re-writings, and persistent dedication. This research stems from my personal interest in improving how our society consumes resources via reusing secondary building components. As an 'entrepreneur re-claiming building components' from the streets of my beloved city, Utrecht, I truly believe these "old" resources hold incredible potential. Don't believe me? Come take a peek at my rooftop terrace!

Despite the fact that writing this thesis has been somewhat a solo-project, I want to give special shout out to some people who supported me along the way. First, a big shout-out to my first supervisor Mart, whose guidance and enthusiasm inspired me throughout these seven months. Second, I would like to thank my second supervisor Jaco for agreeing to supervise me when I was in need of one. Both Mart and Jaco helped me improving my academic skills from understanding theoretical perspectives to academic writing and data analysis.

Also thanks Irina, although our research paths separated during the process, we both began from the same foundation. Specifically, I remember the interesting Monday morning discussion I had with Mart and Irina regarding social practices.

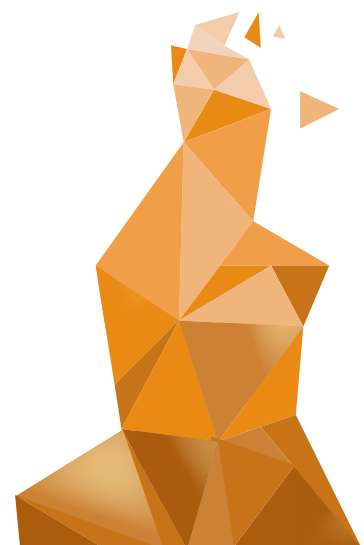
I also want to express gratitude to all the people who participated in the interviews, observations, and the focus group discussion. They might be called "data" in this research, but our conversations were up most interesting, and I'm grateful for your insights and help.

Last but not least, many thanks to Martina for her continuous support and care, she has kept a loving eye over me, and to Casper and Domenique for proofreading parts of this extensive document.

So here it is, my magnum opus—an exploration of knowledge, fueled by curiosity, and enriched by the help of remarkable people. I hope it inspires and captivates you as much as it has me.

Enjoy the reading-journey!

Quinten Isselman



II. ABSTRACT

The construction industry's substantial consumption of materials, CO² emissions, and construction and demolition waste underscore the pressing need for change. One promising solution is the reuse of secondary building components, which has the potential to significantly mitigate these environmental impacts. Circular Building Hubs (CBHs) have emerged as a novel business concept that could facilitate the collection and processing of these components, thereby promoting their reuse. However, effectively scaling up their operational secondary building component supply processes (supply processes) requires changes in the practices embedded in these processes.

Therefore, this exploratory research aimed to identify the extend to which constraining and enabling factors influence the scalability of core practices embedded in supply processes of these CBHs. The core practices are those considered to be essential for the CBH concept. As such, it intended at contributing to new and more comprehensive understanding on the effects of these factors and thereby contribute to the development and scaling up of these processes. Hence, the main research question is as follow: 'What are core practices embedded within the secondary supply processes for circular building hubs, and to what extent are involved constraining and enabling factors influencing the scalability of these practices?'

This research adopts a qualitative case study research approach, centered around a conceptual framework based upon Social Practice Theory (SPT) and hypothesized supply processes. This study incorporates semi-structured interviews with seven experts, four observations, and one focus group discussion (FGD), all conducted in the Netherlands.

The results conclude that throughout 10 different supply processes, 37 different core practices are performed that contribute to the supply of secondary building components for CBHs. Furthermore, the research revealed that these core practices are affected by at least 29 constraining and 26 enabling factors. The research categorizes the influence of factors on core practices as low, medium, or high impact based on quantitative data from CBH supply process experts. The FGD emphasized that constraining and enabling factors affecting core practices in CBHs are highly complex and context-dependent. These factors are influenced by various contextual aspects, business strategies, and specific project conditions. In conclusion, there is no one-size-fits-all solution, highlighting the importance of customized strategies to address constraining factors and enhance enabling factors for scaling core practices within the supply processes of CBHs. Further research is required on exploring CBHs with diverse historical backgrounds to identify new constraining and enabling factors specific to their context.

III. GLOSSARY OF ABBREVIATIONS AND ACRONYMS

CBH/ CBHs	Circular Building Hub/ (s)
CE	Circular Economy concept
CDW	Construction and Demolition Waste
SPT	Social Practice Theory
FGD	Focus Group Discussion
B2B	Business-to-Business
B2C	and Business-to-Consumer
ID	Invalid Data
Supply processes	All operational secondary building component supply processes (e.g. Inventory, collecting, transporting, inspecting, sorting,. Etc)
Core practices	Practices-as-entities that are embedded in the supply processes and are the ones considered to be essential for the CBH concept.
'Bokken'	Smaller transport-racks used to transport building components with
NEN-normen,	A Dutch national standardized norm for technical specifications and guide lines for various aspects of building materials, structures and processes

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1. INTRODUCTION

1.1 Context

The construction industry is responsible for high amounts of consumption of materials, CO² emissions, and construction and demolition waste. In Europe, it is the biggest driver of resource consumption and waste generation (Zhang et al., 2022). Here, construction and demolition waste (CDW) accounts for more than a third of all waste (European Commission, n.d.), while the industry accounts for half of all the resource extraction (Zhang et al., 2022). Moreover, the total CO² emission of Europe's construction sector accounts for 18% of total CO² emission produced from all economic activities (Huang et al., 2018). At the same time, many buildings in Europe are becoming "aged" (Thomsen & van der Flier, 2009), as over 40% of buildings predate 1960, and approximately 85% were built before 1990 (Dubois & Allacker, 2015). Adding to this, recent functional and economic considerations regarding the choice between the entire replacement or life cycle extension of the buildings, resulting in an increase in CDW (Thomsen & van der Flier, 2009). Hence, with all these developments there is a growing concern about the environmental impacts of the sector (Adams et al., 2017).

Although the Netherlands is known for its higher standards regarding CDW management practices among European countries (Zhang et al., 2022), the construction industry still has major negative environmental effects. It is estimated that in this country the construction industry accounts for 50% of raw materials,- 40% of total energy,- 30% of total water consumption, and approximately 35% of CO² emissions (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2016). Additionally, CDW constitutes roughly 40% of the total waste generated in the country (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2016). Moreover, according to Thomsen & van der Flier (2009), the Netherlands has a notably higher and increasing demolition rate than its neighbors. Meanwhile, the housing

demand in the Netherlands is rising, resulting in plans to build around 100,000 units per year (Ministerie van Algemene Zaken, 2021). Finally, there is an increasing concern about material scarcity (Adams et al., 2017). Consequently, due to these high and increasing numbers, CDW management is gaining attention from experts (Karamanou, 2019) and Dutch "companies in the construction sector are increasingly aware of the increasing need to close material chain loops" (Schut et al., 2015, p. 18). Thus, implementing new strategies in the construction sector to reduce material consumption, CDW, and CO² emissions is necessary.

1.2 Circular economy concept

The Circular Economy concept has been recognized as an approach to effectively realize circularity within the built environment thereby reducing construction material consumption, CDW, and CO² emissions (Adams et al., 2017; Zhang et al., 2022). Moreover, it can help with the protection of material resource scarcity (Adams et al., 2017).

Circularity refers to a shift away from linear systems, which rely on an infinite supply of new resources and produce waste as outputs (Adams et al., 2017), towards circular systems that aim to minimize waste and maximize resource efficiency. Hence, the Circular Economy (CE) concept evolved to "emphasize the design and use of a product before it turns into waste" (Zhang et al., 2022). Although different definitions of the CE concept exist (Adams et al., 2017; Kirchherr et al., 2017), a circular economy is often described as "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes" (Kirchherr et al., 2017, p. 229).

Acknowledging the need to establish effective waste management policies throughout European countries and address these challenges, the European Commission has proposed circular economy targets (European Commission, 2020). Following the lead of the European Commission, the Dutch national government introduced a government-wide program called 'Rijksbreed Programma

Nederland Circulair in 2050' (2016) aimed at developing a fully circular economy in the Netherlands by 2050 (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2016).

1.3 Reusing secondary building components

The CE concept is often discussed in the context of the R-principles (Zhang et al., 2022), outlining different gradations or options for circularity strategies. Throughout the years, academia have extended the basic 3R-principles (Reduce, Reuse, and Recycle) to include additional actions that promote circularity, including: Recover, Remanufacture, Refuse, Rethink, Repair, Refurbish, and Repurpose (Gharfalkar et al., 2015; Kirchherr et al., 2017; Potting et al., 2016). However, for his research, only the R-principles Reuse, Repair, Refurbish, Remanufacture, and Repurpose are included.

The R-principles Refuse, Rethink, and Reduce ('pre-use' phase principles), the highest-ranked principles, can significantly improve resource effectiveness and reduce the generation of new CDW and CO² emissions (Zhang et al., 2022). However, to improve resource effectiveness, these factors largely depend on the product design phase, which involves new to-build buildings/structures. Hence, a distinct characteristic that these R-principles have in comparison to the others is that they don't support the circularity of secondary building components and materials, but the prevention of the using them (Potting et al., 2016). Therefore, since they do not prevent CDW coming from the current building structures (e.g. buildings, bridges, walls, etc.) they are taken out of the scope of this research.

From a sustainability perspective, the R-principles Recycle and Recover ('post-use' phase principles) are the two least favored principles to use since they require vast amounts of energy and many resources and thus still produce CO² emissions (Gerding et al., 2021; Rakhshan et al., 2020a; Zhang et al., 2022). Besides, time and again new components made from recycled materials are degrading in function, quality, and value (downcycled) (Adams et al., 2017). Finally, new resources must still be extracted to replace downcycled

products. Therefore, although these principles might be useful from certain perspectives, these R-principles are taken out of the scope of this research.

Recycling requires the processing of building components into (raw) materials (Iacovidou & Purnell, 2016), also called 'bulk materials' (Allison, n.d.). Hence, the term 'building material reuse' often refers to the reuse of bulk materials, sometimes including the restoration of these bulk materials into new or similar products or building components (Gerding et al., 2021; Rakhshan et al., 2020a). Since recycling is taken out of the scope of this research, so are the reuse processes of raw (building) materials, including the involved processes of processing them again into new building components.

The R-principles Reuse, Repair, Refurbish, Remanufacture, and Repurpose ('use phase' principles) are designed to extend the lifetime of both components (e.g. window frames, toilets, doors, and wooden products) and products (e.g. entire buildings and structures) (Zhang et al., 2022). In the construction sector, the latter translates to "adaptive reuse" or "building reuse," which reduces construction material consumption, CDW, and CO² emissions (Gorgolewski, 2008; Rakhshan et al., 2020a). From the CE point of view, this is the best reuse option (Gálvez-Martos et al., 2018; Rakhshan et al., 2020a). However, while buildings have long lifespans (Pomponi & Moncaster, 2017), eventually building structures such as houses are prone to be demolished due to factors like space limitations, refurbishment costs, changes in building regulations and design standards, structural integrity, and client preferences (Gálvez-Martos et al., 2018). Hence, this research focuses only on the reuse of building components, and 'adaptive reuse' or 'building reuse' is taken out of the scope of this research.

In the construction sector, the use phase R-principles are often all viewed under the same umbrella term 'Reuse' and a clear distinction is often neglected (Gerding et al., 2021; Gharfalkar et al., 2016). This might be explained since, eventually, CDW, or in more fitting terms: secondary building components, are being reused with all these R-principles. However, for this research,

there is a distinction. Reuse refers to a process in which the same component ends up with the same function, with or without processing of the component (Schut et al., 2015). Repurpose refers to the process of a component, or part of it, ending up with a different function. Repair, Refurbishing, and Remanufacturing are principles in which building components are processed (Gharfalkar et al., 2016; Johnson & McCarthy, 2014; Schut et al., 2015; Seitz & Wells, 2006). After components are processed, they are either reused or repurposed. Hence reusing secondary building components does not have to encompass the R-principles of repair, refurbish, or remanufacture since not all building components require processing.

Reusing or repurposing secondary building components within the construction sector has major beneficial effects on CDW prevention and thereby lowering construction material consumption, and CO² emissions (Gálvez-Martos et al., 2018; Rakhshan et al., 2020a). Moreover, the potential supply of stored components in building structures (e.g. buildings, bridges, walls, etc.) is significant (Schut et al., 2015). Finally, reusing secondary building components offers economic and social benefits such as the possible creation of new business models and jobs (Ghisellini et al., 2018; Iacovidou & Purnell, 2016). Therefore, the use phase R-principles will be taken into account for this research.

1.4 The circular building hub

To stimulate the reuse processes of secondary building components from the current stock of building structures, new concepts must be introduced. One emerging new reuse business model concept (Iacovidou & Purnell, 2016), that facilitates the reuse of building components (Ramli, 2020), and therefore the main focus of this research is the 'Circular building hub'. Although it is difficult to pinpoint the exact origin of circular building hubs (CBHs or CBH) (Ramli, 2020), recognizing from which concept they likely developed is relevant for understanding its core mechanisms.

1.4.1 The development of the Circular building hub

The building/logistic hub

Traditionally, building hubs, also called construction- or logistics hubs, are a way to better organize goods flows between parties (de Bes et al., 2018). Logistics incorporate the strategic orchestration of planning, implementation, and control, ensuring the smooth and efficient flow of goods and services in both forward and reverse directions, from the point of origin to the point of consumption and back (Kozlenkova et al., 2015). Hence, a construction or logistic hub usually refers to a central location outside the city, where multiple logistical functions come together to facilitate major construction projects in the city or region (van Hoogdalem, 2022).

Currently, in the construction sector, logistics, or construction traffic, is a substantial source of harmful emissions (CO², NO^x, and PM¹⁰) and has a profound influence on various aspects, including climate, quality of life, accessibility (congestion), and air quality within urban areas (Ranieri et al., 2018; van Merriënboer & Rondaij, 2020). However, construction or logistic hubs can result in fewer transport movements, less congestion, and better air quality in the city or region (de Bes et al., 2018; van Hoogdalem, 2022), which might be part of why they were developed. Loeber & Snoek (2020) add that these hubs have arisen due to difficult and time-consuming transportation in inner-city construction projects, including too little room for storage of building components and materials at these inner-city locations. Therefore, at these hubs, (new) building components and materials often undergo an inspection and short-term storage before being bundled and conveyed to the designated construction site, and thus making last-minute urgent delivery possible (de Bes et al., 2018).

In the transition to the CE however, and more specifically in relation to a circular construction sector, efficient logistics regarding the processing and reuse of secondary building components (and materials) for the construction sector becomes an important challenge (Gemeente Amsterdam, 2021). This is because the transition starts at the logistics

of disassembling, storage, and supply of used building components (Doepel et al., 2015). Hence, before reuse can be stimulated/applied in the design and construction phases for new projects (Rakhshan et al., 2020a), secondary building components need to be made available.

The circular building hub

In an exploratory research about the circular building hub (also referred to as a 'circular construction hub' or 'circular building materials hub'), Cirkelstad together with the Dutch 'Ministry of Domestic Affairs' (Ministerie van Binnenlandse Zaken), states that: *"The circular construction hub [...] goes further than the logistics hub, with the primary goal of actively bringing together parties within the chain from the primary and secondary cycles"* (van Hoogdalem, 2022, p.5). Hence, in contrast to more traditional building or logistic hubs, the CBH offers possibilities to stimulate the reuse of secondary building components.

1.4.2 Definition of the circular building hub

According to Nieuwhoff (2022), CBHs are places where the *"collection, sorting and processing [of] non-bulk construction and demolition waste to secondary materials takes place"* (p.20). Another function of CBHs, that is more commonly agreed upon, is to store secondary building components (and materials) that are harvested/collected from disassembling projects (Gemeente Amsterdam, 2021; Nieuwhoff, 2022). By this means, one of its goals is to adjust differences in the availability of the supply and demand of these secondary building components (Ramli, 2020). Hence, these hubs function as a 'repository and marketplace' (Gemeente Amsterdam, 2021) of such components and incorporate a logistical function (Nieuwhoff, 2022).

Although Nieuwhoff (2022) mentioned that the *"materials are primarily finishing materials [components], such as frames and doors and wooden products"* (Nieuwhoff, 2022, p.20), he does not specify that the output after 'collection, sorting and processing' processes are bulk materials (raw materials), reusable components or both. Ramli

(n.d.), states that *"CBMH [circular building materials hub] can be considered an umbrella term for similar concepts of reusing materials originating from building demolitions"* (p.10). This implies that transportation from a demolition or disassembling site to the CBH is involved. For this research, the sites where the extraction or retrieval of building components from various building structures takes place will be called: Disassembling sites.

Due to a lack of a common agreement on the exact definition of a CBH and its processes, including the components (material) types (e.g. wood, glass, steel, etc.), and because this research focuses specifically on the R-principles: Reuse, Repair, Refurbish, Remanufacture, and/or Repurpose, this research defines sites as CBHs when they meet the following definition:

A physical location where construction and demolition waste in the form of building components of diverse material types from disassembling sites, are transported to, and/or sorted, inspected, prepared, and/or when required repaired, refurbished, and/or remanufactured, to be either stored at the hub, or reused or repurposed as secondary building components for new construction projects.

Next to this definition, this research establishes the following hypotheses regarding all the involved processes related to the concepts of CBHs:

First, since the secondary building components derive from existing building structures from where they are collected or disassembled, this process, often discussed under the umbrella term 'Urban Mining', is linked to the supply processes of CBH. Urban Mining is often described as *"all the activities and processes of reclaiming compounds, energy, and elements from products, buildings, and waste generated from urban catabolism"* (Di Maria et al., 2013, p. 2594). The process can encompass the retrieval of building components (and materials) from various building structures, including buildings, industries, products (both in and out of use), etc. (Cossu & Williams, 2015). Other more specific terminology in literature used in the construction sector is 'smart dismantling'

or 'selective demolition' (Zhang et al., 2022), which refers to a more specific technique of carefully dismantling a structure and salvaging reusable components (and materials) for recycling or reuse purposes. Both concepts refer to the extraction of secondary building components (and materials) from the various building structures.

Second, to execute a collection or smart dismantling of building components from building structures, the knowledge of which components are present is needed. Hence, making an inventory (also called material or waste audit) before the dismantling is often conducted (Gorgolewski, 2008; Loeber & Snoek, 2020; Rašković et al., 2020; Rose & Stegemann, 2018). Rose & Stegemann (2018) state the following: *"This [the material audit] could be in the form of a pre-redevelopment audit, or informal identification of reusable components, such as the practical knowledge that a demolition contractor may apply when tendering a job"* (p. 10). Hence, making an inventory is likewise linked to the supply processes of CBH. For this research, the extraction or retrieval of building components from various building structures via techniques such as 'smart dismantling' will be called the collecting process. The making of an inventory or material audit will be called the inventory process.

To conclude, the processing process begins at the disassembling site where building components are collected after an inventory is conducted. Therefore, all processes that stimulate the reuse of building components starting at the disassembling site, will be taken into account. Consequently, the hypothesis is that the following processes are linked to the supply of secondary building components for CBHs and are therefore taken into account for this research: Inventory, collecting, transporting, inspecting, sorting, repairing, refurbishing, remanufacturing, preparing, and storing. All these processes will for further use in this research be called 'operational secondary building component supply processes', or in short: 'supply processes'. 'Supply' indicates the supply of secondary building components for the CBH. After these processes, the secondary building components either get reused or repurposed for construction projects.

1.5 Focusing on practices

As discussed, aiming for a circular construction sector, it is important to shift away from the linear system of building component discharging, towards a circular system (the CE concept), in which secondary building components are reused. To facilitate the transition to this circular system, *"technological and regulatory developments alone will not suffice, a shift is required in [...] stakeholders' behaviors and attitudes"* (Hart et al., 2019, p. 619). Ultimately, the operational secondary building component supply processes (supply processes) of CBHs, require certain changes in the activities and practices that people perform in the current linear system, including behavioral and attitude changes. Doepel et al. (2015) phrases this change in activities and practices in the construction sector compellingly: *"No more demolition and removal of building rubble to the waste heap, but moving components from one construction project to another"* (p.13).

Gorgolewski (2008) points out that, although some companies have identified reuse as a business opportunity, *"demolition rather than deconstruction [dismantling] is still generally the rule for perceived economic and programming reasons"* (p. 186). Hence, implementing reuse activities to effectively reduce the consumption of materials, CO₂ emissions, and CDW, requires not only technically sound CBHs and innovative techniques, but also fitting attitudes and practices performed by the people involved.

Some authors point out that in order to scale up the (re)use of secondary building components, a sufficient supply of these components must first be established (Loeber & Snoek, 2020; van Merriënboer & Rondaij, 2020). As an example, Gorgolewski (2008) states that *"an increase in deconstruction practices will improve the supply of reused [building] components"* (p. 186). However, Ramli (2020) states that from the technological side of transitioning into a circular built environment, the technology already exists, but the main problem lies with the upscaling of these innovations.

Hence, the question arises which practices are involved in supply processes of CBHs and can be exploited to further support the development

and scaling up of these processes. Consequently, by focusing on the practices involved in the supply processes, such as the disassembling of buildings, a better understanding of how they contribute to the mechanisms and overall effectiveness of the CBHs can be understood. Specifically when the core practices of these supply processes, the practices that are essential for the CBH concept, are examined and understood, can this knowledge help CBHs to be further developed and implemented in diverse contexts. Accordingly, this knowledge can help with identifying valuable insights for implementing interventions or strategies aimed at promoting desired changes in the practices involved. As such, it can help support and/or with scaling up of these supply processes to eventually increase the reuse of secondary building components.

To gain a deeper understanding of the mechanism of the core practices within the supply processes in CBHs, this research will likewise focus on constraining and enabling factors that are embedded within these supply processes and help constitute the involved core practices. As such, it tries to unravel which factors support changes in these practices (the enabling factors) and which factors hinder changes (the constraining factors).

Finally, the practices within the supply process that help institutionalize these changes, reside in a socio-technical system in which the CBHs take part. To explain how this change can be instituted and create strong ripple effects to help achieve a more circular construction sector, this research takes on the perspective described by Watson (2012): *“changes in socio-technical systems only happen if the practices which embed those systems in the routines and rhythms of life change; and if those practices change, then so will the socio-technical system”* (p. 489). In other words, if new core practices within the CBH's supply processes, that extensively support and scale the supply of secondary building components, can be established, this might initiate an increase in the reuse of secondary building components in other parts of the construction sector as well.

1.6 Problem statement & Knowledge gap

The high amounts of consumption of materials, CDW, and CO² emissions in the construction sector, reveal the urgency for a change in this sector. One solution is reusing secondary building components since this can significantly reduce these factors. To stimulate the reuse of secondary building components the emerging business concept of the 'circular building hub' (CBH) could potentially facilitate the process of collecting and processing of these components. However, effectively scaling up the reuse activities in the supply processes of these CBHs, requires changes in the core practices performed by the people involved. As such, understanding these practices and how they contribute to the mechanisms and overall effectiveness of the CBH's supply processes can be an advantage to eventually increase secondary building component reuse.

Although much research has been conducted on the effects of the traditional building hubs (van Hoogdalem, 2022), mostly referring to logistics hubs, the CBH is a relatively new concept (Ramli, 2020). From preliminary research, it could be concluded that in-depth research regarding the mechanism of these hubs is lacking. The benefits of reusing building components and constraining and enabling factors regarding the reuse of these components, including relevant techniques such as selective demolition and tools such as material passports, have widely been researched (Gorgolewski, 2008; Hart et al., 2019; Rakhshan et al., 2020a; Rašković et al., 2020; Rose & Stegemann, 2018), which will be further outlined in chapter 2. Also, some authors revealed some general potential benefits of CBHs for reusing secondary building components in explorative studies (Loeber & Snoek, 2020; Nieuwhoff, 2022; van Hoogdalem, 2022) and one study was found regarding the spatial parameters for CBHs (Tsui et al., 2023). However, in-depth research regarding the relation between constraining and enabling factors and the practices performed in the supply processes of CBHs is to the author's knowledge still unexplored in an academic setting.

1.7 Research objective, relevance and scope

By taking the practices, performed by the people involved in the supply processes for CBHs, as a focus point, this exploratory research tries to gain a deeper understanding of the mechanisms of these processes. Moreover, it tries to unravel which constraining and enabling factors influence the core practices. With these insights, the main objective of this exploratory research is to unravel how the scaling up of these processes can be improved.

This exploratory research aims to contribute new insights to scientific literature regarding the effects of the involved core practices on the supply processes of CBHs. Furthermore, it will add knowledge to the current gap in the literature regarding the mechanism of CBHs (Nieuwhoff, 2022). Consequently, it can help with the further development and scaling up of these CBHs and with the establishment of new practices that ultimately promote the reuse of secondary building components via both existing and new CBHs. Moreover, with the growing concern about the environmental impacts of the construction sector (Adams et al., 2017) and the increasing urbaniza-

tion of both Dutch and worldwide metropolitan areas (Centraal Bureau voor de Statistiek, n.d.), it is expected that these urban areas will have the largest increase in building structures. Hence, promoting the reuse of secondary building components has major implications for decreasing the environmental footprint of our cities.

Due to time limitations, and because they are the most relevant practices for understanding the central supply mechanisms, only the (core) practices within the operational activities of the supply processes, including practices that are directly linked to these practices, will be taken into account in this research. The operational activities refer to the series of activities and tasks that are carried out on a day-to-day basis to achieve the operational goals and objectives within the inventory, collecting, inspecting, sorting, repairing, refurbishing, remanufacturing, preparing, and storing supply processes. The directly linked processes and practices might involve administrative processes such as planning, budgeting, and performance measurement.

Since this research focuses on the supply of secondary building components for CBHs, which must first be established to promote the reuse of secondary building components (Loeber &

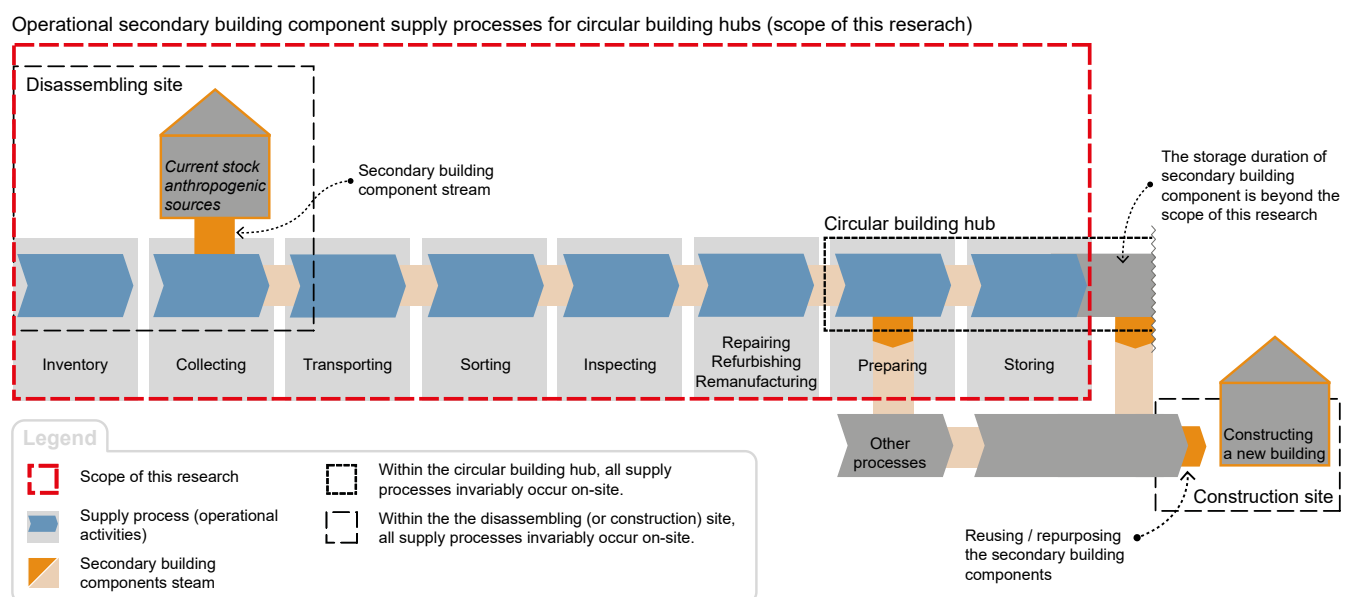


Figure 1-1: Illustrative overview of all the hypothesized secondary building component supply processes and the scope of this research.

Snoek, 2020; van Merriënboer & Rondaij, 2020), the processes onward for reuse or repurposing, after storing or preparing (when storage is not required), are taken out of the scope of this research. No limitation regarding the type of origin of the building components from building structures (e.g. buildings, bridges, walls, etc.) is defined. However, only components from building structures are examined, and street furniture for example is excluded. Finally, no limitations are set as to how long the secondary building components should be stored. Figure 1-1 on page 16 shows an overview of the supply processes and the scope of this research.

Only CBHs in the Netherlands will be examined due to several reasons. First, the demolition rates in the Netherlands are much higher compared to other European countries (Thomsen & van der Flier, 2009). Furthermore, Monier et al., (2017) found that the country has the most mature CHW management practices of the whole of Europe. For example, it has 99% of CDW recovery rates, although over 95% of waste concrete is downcycled. Finally, the country also has many industry initiatives in which “buildings or entire districts are built with the use of CDW” (Monier et al., 2017, p. 184). Hence, the country is interesting due to good conditions for potential secondary building component reuse via CBHs.

1.8 Research questions

Having established the preceding analysis, the relevant contexts and having explored the relevant concepts, this research seamlessly gravitates towards the following main research question:

What are core practices embedded within the secondary supply processes for circular building hubs, and to what extent are involved constraining and enabling factors influencing the scalability of these practices?

1.8.1 Sub-questions

To comprehensively address the main research question, the following sub-questions are formulated to assist and guide the research process:

❧ *What are the core practices involved in the secondary supply processes for circular building hubs?*

❧ *What are constraining and enabling factors that shape these core practices?*

❧ *What is the influence of the identified constraining and enabling factors on the scalability of these core practices?*

1.9 Readers guide

The following structure is adopted for this research. Chapter 2 offers an overview of relevant literature, covering the potential benefits, constraining, and enabling factors of reusing secondary building components that were found during preliminary research. The understanding of these factors provides the context necessary to investigate and improve practices within the supply processes of CBHs. Moving forward, chapter 3 presents the theoretical framework, providing an elaborate explanation of the theory of social practices. This framework serves as the fundamental basis for developing a conceptual model. Chapter 4 outlines the conceptual framework constructed for this research. It transforms both the notion of the hypothesized supply processes and the theoretical framework into an applicable structure, effectively visualizing the key research concepts. Chapter 5 explains the research methodology, explaining the case study selection criteria, data collection techniques, and data analysis processes. In Chapter 6, the research outcomes are presented and analyzed. The case study insights are discussed first, followed by an exploration of the operational supply processes for secondary building components, the core practices-as-entities, and the constraining and enabling factors influencing these processes. Chapter 7 offers an interpretation and discussion of the research findings to address the research question. This chapter also acknowledges research limitations and presents the personal reflection. Chapter 8 presents the conclusion of this research and also provides recommendations for CBHs and further research. Finally, the references and appendixes are provided.

2. CONSTRAINING AND ENABLING FACTORS FROM LITERATURE

2.1 Introduction

This chapter further elaborates insights that were found from reviewing literature in the preliminary phase of this research, regarding the reuse of secondary building components. In chapter 1, some of these aspects have been touched upon. To gain a deeper understanding and a more grounded perspective of the potential benefits on reusing of secondary building components and constraining and enabling factors that stimulate this, this chapter elaborates the results from reviewing literature during the preliminary phase of this research. The understanding of these factors provides the context which helps to investigate and improve practices within the supply processes of CBHs. Henceforth, first the benefits of reusing building components will be discussed. Second, the constraining and enabling factors for the supply processes are elaborated.

2.2 Benefits of reusing building components

Reusing secondary building components has several benefits. First, even though minimal reprocessing of the components might be needed, the required energy for reusing building components is much lower compared to recycling (Iacovidou & Purnell, 2016; Rakhshan et al., 2020a).

Second, reusing building components slows down the resource loop (Gerding et al., 2021), and can therefore reduce CDW.

Third, according to Gálvez-Martos et al., (2018), practically *“zero waste amount sent to landfill is achievable if re-use is integrated with other best practices.”* (p. 176). In the same review study, Gálvez-Martos et al., (2018) found that *“the re-use of building components and construction products*

has a significant effect on the overall life cycle environmental performance of the construction activity. Approximately 40% of embodied energy can be saved, despite an increase in transportation needs” (p. 174). Examining the reuse of structural steel or timber components specifically, it can reduce the environmental impacts by 96% and 83%, respectively (Rakhshan et al., 2020a).

Fourth, Ghisellini et al., (2018) state that in most cases the reuse of secondary building components not only provides environmental, but also economic benefits. For example, because of the potential cost savings from reusing those components (Rakhshan et al., 2020a), but also due to the possible creation of new business models (Ghisellini et al., 2018; Iacovidou & Purnell, 2016).

Finally, adding to this, it can also provide social benefits such as the possible creation of new jobs (Ghisellini et al., 2018; Iacovidou & Purnell, 2016).

2.3 Constraining factors for reuse

Various studies have identified multiple constraining factors that prevent the reuse of building components.

First, because disassembling is not considered during the design phase of buildings, the building components are more difficult to disassemble and more likely to be damaged during the disassembling phase (Rašković et al., 2020). This results in more extensive labor when sorting the secondary building components after these are disassembled (Schut et al., 2015). Adding to this, it is crucial to know the quality of secondary building components (e.g. quality certifications), but since this wasn't considered in advance, it is difficult to trace back this knowledge (Rakhshan et al., 2020).

Second, because only a small part of the existing building structures and their building components is being digitized (e.g. with material passports) there is little knowledge about those components for disassembling teams, which slows down the process (Loeber & Snoek, 2020). Adding to this, disassembling teams are engaged relatively late in the process. As a result, there is limited time

available for the comprehensive inventory and disassembly of the building components (Loeber & Snoek, 2020).

Third, disassembling (or harvesting) instead of demolition, of building components for reuse is more labor intensive and requires more time (Gorgolewski, 2008). Adding to this, the lack of skills, experience, and knowledge in disassembling of buildings is often a large barrier (Rakhshan et al., 2020). Moreover, existing regulations do not support disassembling processes (Rakhshan et al., 2020).

Fourth, there are additional storage costs when direct-reuse, reusing without the need of a place to process or store the components, of components is not possible, including transportation and processing costs (Rakhshan et al., 2020). Additionally, lower disposal costs further suppress the probability of storage (Hosseini et al., 2015).

Fifth, the entire system intergraded in the construction sector is often more focused on short-term profit instead of longer-term activities with delayed financial profitability (Knoth et al., 2022). Adding to this, the absence of a robust market for these reusable building components combined with a surplus of available stock is the main obstacle (Gálvez-Martos et al., 2018). This is enhanced by the heterogeneously of the available secondary building components, which in turn hinders the development of a robust market. Likewise, there is a lack of supply chain coordination and integration which blocks efficient communication and proper reuse of building components, though both are important for the reusing market (Hosseini et al., 2015). Hence there is a mismatch in supply and demand regarding time, location, volume, and quality (Gemeente Amsterdam, 2021).

Sixth, in the entire chain of stakeholders, there is often a lack of awareness about the economic and environmental benefits of the reuse of building components (Hart et al., 2019; Hosseini et al., 2015; Rakhshan et al., 2020a). This is backed by a conservative way of thinking by these actors (Knoth et al., 2022). Finally, the lacking of a well-ingrained reuse market results in a lack of trust in suppliers of reused components (Rakhshan et al., 2020).

Finally, secondary building components are

hardly cheaper than primary material. Frequently, the cost of virgin materials is lower than the expenses associated with acquiring secondary materials (Loeber & Snoek, 2020).

2.4 Enabling factors for reuse

First, reusing building components can be stimulated via the disassembling of the building and its components, instead of demolishing, which can improve the reusability of the building components (Rakhshan et al., 2020a). This process is also called 'smart dismantling' or 'selective demolition' (Zhang et al., 2022). Such processes are encouraged by the availability of regulatory and financial incentives, and by the existence of regulations supporting these interventions (Rakhshan et al., 2020a). Streamlining the process of smart dismantling by a so called 'chain director' can guarantee the building owner of the highest quality processing of secondary building components which also can stimulate reusing processes (Crielaard, 2015, p. 24). Equally, visualization tools that stimulate the selective demolition both in planning and also to *"allow one to foster demolition practices according to the waste management priorities"* stimulate the disassembling of the building (Rašković et al., 2020, p. 926). Also, performing a desk study or preliminary (historical) research to draw *"as much relevant information as possible from available documentations about the building itself and notable activities that took place during the service life of the building"* can stimulate the disassembling of the building (Rašković et al., 2020, p. 925). Likewise, a site visit or field survey (inventory) *"intended as a general analysis of the actual constitution of the building"* stimulates the disassembling processes (Rašković et al., 2020, p. 925). Also, providing enough time (e.g. provided by the client) for the disassembling team to conduct the inventory, disassembling and other practices is important (Loeber & Snoek, 2020). Or like Gorgolewski (2008) states: *"the role of the client is crucial in any deconstruction and reuse strategy"* (p. 186).

Second, accurate separation of the components after these disassembling processes, stimulates the reuse of these building components. Therefore,

"training operators for effective deconstruction" and separation and the availability of space for storage are factors that enhance reusability (Rakhshan et al., 2020, p. 359).

Third, the available information regarding the *"characteristics, details, certificates and drawings of the recovered building components"* can positively influence the reuse of these components (Rakhshan et al., 2020, p. 360). Involving the manufacturers can stimulate this information sharing since they possess a distinctive advantage in knowledge regarding the structure, durability, and other characteristics of building components (Rakhshan et al., 2020a).

Fourth, the implementation of quality certifications and manufacturer guarantees for used building components could encourage the growth of reuse (Rakhshan et al., 2020a).

Fifth, regulations supporting product reuse, coupled with financial and regulatory incentives to promote disassembling, can foster greater adoption of reuse practices (Rakhshan et al., 2020a).

Sixth, including a digital marketplace to increase synergy between the coordination of supply and demand (Gemeente Amsterdam, 2021)

Finally, factors such as environmental concerns within the society and the increase in awareness of the potentials of reusing building components among all the stakeholders involved (e.g. of the construction workers) stimulates reusing processes (Rakhshan et al., 2020a).

reuse. Constraining factors limiting the supply processes of secondary building components include limited design oversights, limited digitization, labor intensity, regulatory barriers, and storage costs. Short-term focus in the construction sector, market heterogeneity, lack of awareness, and cost differences challenge the supply processes. Hence, by outlining the benefits, constraining and enabling factors, this background literature study provides the context necessary to investigate and improving practices within the supply processes of CBHs.

2.5 Concluding chapter 2

In conclusion, this chapter provides a foundational understanding of reusing secondary building components. It emphasizes benefits like lower energy consumption and reduced environmental impacts. Reuse slows the resource loop and offers both economic and environmental gains. Enabling factors supporting the supply processes of secondary building components include techniques like "smart dismantling," regulatory incentives, and information availability. Moreover, factors like accurate separation, involving manufacturers, quality certifications, and awareness also foster

3. THEORETICAL FRAMEWORK

3.1 Introduction

This chapter elaborates the theoretical framework which is utilized throughout this research. As described in the introduction, this research adopts the perspective outlined by Watson (2012), which states that change within socio-technical systems relies on the alteration of embedded practices. Hence, if (new) practices can be established within the operational secondary building component supply processes (supply processes) that further support and scale the supply of secondary building components to circular building hubs (CBHs), this might initiate an increase in the reuse of secondary building components in other parts of the construction sector as well. Therefore, to support the continued development and scaling up of these supply processes, it is important to explore and understand the changes required in the activities or practices of individuals involved in these processes. This research recognizes that to effectively understand these supply processes and propose interventions for scaling up, an in-depth investigation into the practices constituting and embedded in these processes is essential.

By studying these practices, a holistic understanding of how they contribute to the overall effectiveness of the supply processes of CBHs can be achieved. Consequently, motivated by the results and concepts of previous work, predominantly that of Shove et al. (2012), this research adopts social practice theory (SPT) as its theoretical framework. SPT is chosen because it excels in conceptualizing the activities, or practices, executed by individuals (Reckwitz, 2002). This enables, for instance, the (repetitive) practices of the supply processes for CBHs to be made the unit of analysis. Furthermore, SPT can help facilitate an analysis of how various contextual factors such as ranging from norms to cultural doings, influences practices within the supply processes (Shove et al., 2012). For example, it can delve into the complex organizational norms

and deeply ingrained cultural beliefs and customs within the construction sector.

Finally, the theory also helps focusing on multiple collective practices that shape and sustain these supply processes. By doing so, a more holistic view of how different practices contribute to the mechanisms and overall effectiveness of the supply processes can be understood. Making it a relevant and useful theoretical perspective for this research. Hence, in this chapter, SPT is outlined.

3.2 Social practice theory

Instead of looking at individuals or social groups to change behavior, or merely at the technical or financial implications, SPT offers another possibility by using practices as an explanatory process for everyday behavior (Reckwitz, 2002). Therefore, SPT sees individuals as the carriers of the practice; the practitioners (Shove et al., 2012).

By using this theory, multiple deeper understandings and the various factors that influence the practices involved in the supply processes for the CBHs can be found. These include the actors and activities involved in the practices, the skills and knowledge required to execute the practices, and the meanings and values associated with practices. Moreover, SPT can help identify barriers and opportunities for changing the practices (Shove et al., 2012), and help develop strategies for these changes (Speck & Hasselkuss, 2015). Thus, SPT provides an opportunity to examine the important practices involved in the supply processes of CBHs and identify specific 'elements' that constitute and facilitate an enabling factor for these processes (Shove et al., 2012).

In conclusion, SPT can provide a more all-encompassing and comprehensive interpretation of the practices involved in for example the supply processes for CBHs. It provides a "means of conceptualizing dynamic processes inherent both in business and in other realms of everyday life" (Shove et al., 2012, p. 12), and helps with developing strategies to encourage practice changes supporting these supply processes.

3.2.1 What is a practice?

Practices are often referred to as shared and routinized behaviors and a way of performing or doing something (Reckwitz, 2002), such as activities like cooking, driving, or demolishing. They can be understood as bundles of multiple interconnected 'elements' (Reckwitz, 2002). A widely used and recognized arrangement of these elements (Svennevik, 2022), that has been further condensed from earlier work (Speck & Hasselkuss, 2015), is that of three distinct types of elements: materials, competences, and meanings (Shove et al., 2012). According to Shove et al. (2012), these elements are bound together by social and cultural norms and conventions.

Materials refer to all physical aspects of the performance of a practice. This includes things, technologies, tangible physical entities, and the stuff of which objects are made (Shove et al., 2012), and thus also includes the body of the practitioner (Holtz, 2014). Examples are a screwdriver, sledgehammer, plateau to stand on, or the building itself.

An important notion is that "through their presence, materials and objects can play a coordinating role in the integration of other practice elements in moments of performance" (Maller, 2015, p. 60). For example, if a university tries to pre-sort recyclables into appropriate categories, the material element of an appropriate recycle bin, for example with distinct compartments, facilitates the sorting process by physically separating different types of recyclables and thus encouraging students to put their trash in the right compartment. Hence, materials act as the directions or carriers of other elements of a practice (Shove et al., 2012).

Meanings refer to the symbolic meanings, ideas, intentions or motivations, emotions, and aims of the practice (Holtz, 2014; Shove et al., 2012). An example is the motivation to reuse building components because it is more sustainable or because it can generate money. It is relevant concerning the performance of the practice, such as the drive to disassemble a building component, but also to the material element (Holtz, 2014). For example, the meanings, such as the intentions or motivations, of the use of a screwdriver are different from the meanings of a sledgehammer. The first is to

(carefully) assemble or disassemble an object (e.g. a building component), and the latter is to demolish or break something.

Competences refer to skills, knowledge, and techniques that are required to perform the practice (Shove et al., 2012). For example, the knowledge of how to carefully disassemble a building to later reuse the different building components, how to use a screwdriver, or the best techniques to demolish a building. However, it is also the understanding of which jobs require certain tools. Hence, competence is also relevant concerning the materials of the practice. Likewise, the element of competences is an abstracted "lump [of] multiple forms of understanding and practical knowledge-ability together" (Shove et al., 2012, p. 23), although there is a differentiation in competences as both tacit (or implicit, also referred to as embodied skills or know-how) and explicit knowledge (Maller, 2015; Shove et al., 2012). These differences can be understood as different "forms of knowing" (Shove et al., 2012, p. 69). They are important to understand since "knowing in the sense of being able to evaluate a performance is not the same as knowing in the sense of having the skills required to perform" (p. 23).

Tacit knowledge refers to the knowledge that is learned through experience, practice, and socialization (Nonaka, 1998). It is often rooted in individuals' habits and ways of doing things. This knowledge is not learned from written down text or taught by other people (Cambridge Dictionary, n.d.-b). Moreover, tacit knowledge is often acquired through repeated engagement in a practice and is closely tied to the embodied skills of individuals.

Embodied skills refer to the physical abilities, techniques, and practices that are learned and developed through bodily experiences and performances. These skills are acquired through practice, repetition, and sensory feedback, and become embodied as bodily memory in practitioners. Embodied skills are closely tied to individuals' physical interactions with the material world and are an essential part of their competences in performing a practice. This knowledge is not easily verbally expressed (Kuijer, 2014), "walking is not difficult to do for most people, but exactly putting

into words how to do it is nearly impossible” (p. 30).

Explicit knowledge is knowledge that is formally collected and communicated in written or verbal form. It includes information, facts, rules, and procedures such as texts and numbers (Cambridge Dictionary, n.d.-a), and can for example be found via computers and books. This form of knowledge can explicitly be communicated and shared among people (Nonaka, 1998). It can be argued that it can complement and reinforce the tacit knowledge and embodied skills that people possess. Finally, explicit knowledge can be converted to tacit knowledge and vice versa (Nonaka, 1998).

It is important that every practice must be comprised of these three elements (Nash et al., 2017), that they are interconnected or linked together, and that they cannot exist or be reduced to a single element (Reckwitz, 2002). Maller (2015) describes this as “it is the presence and integration of all three of these elements in the moment of performance that a practice is realized” (p. 58). However, the elements can exist separately before links between them are made, and can still exist after the links between them are broken. (Shove et al., 2012) calls these ‘proto-practices’ and ‘ex-practices’ respectively (See Figure 3-1 on page 23).

Shove et al., (2012) shows how different social practices can be interrelated by sharing similar elements. For example, in the past, driving and repairing cars shared a common image of masculinity; the element of meaning. Furthermore, it is through the circulation of the three elements that individuals, the practitioners, are recruited to carry

out and perform a practice. This then ensures the continued existence or decrease of the practices (Maller, 2015). Also, by focusing on the trajectories of these elements, and how links between them are being created and broken down, the changes and the consistency of the practices can be examined (Shove et al., 2012).

3.2.2 Practices as entities and as performances

A useful approach for empirical studies is the distinction between practice-as-entity and practice-as-performance (Maller, 2015), a terminology that will further be used in this research. It enables researchers to theorize about practice change, “as it is through repeated performances that practices can be observed to persist and evolve or fade and disappear” (Maller, 2015, p. 59). The distinction could be described as a way of looking at the practices from two different perspectives. However, both perspectives are important for understanding social practices, as they complement each other and provide a more complete understanding of how practices work, hence they are connected (Svennevik, 2022).

Practice-as-entity

The perspective of practice-as-entity sees practices as distinguishable concepts such as driving, cooking, and demolishing (Shove et al., 2012; Shove & Pantzar, 2007) which are relatively stable (Maller, 2015). From this perspective, elements that create the practice are a recognizable pattern of

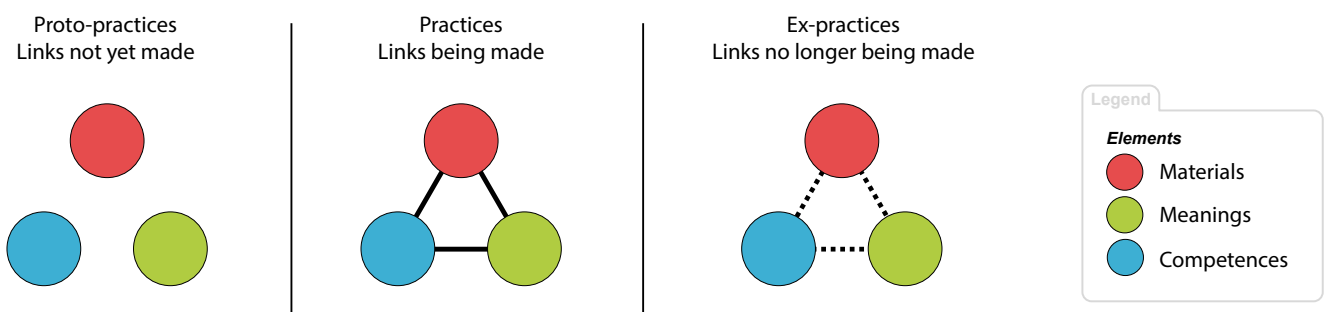


Figure 3-1: Illustrative overview of the three elements that can exist separately before links between them are made, and can still exist after the links between them are broken. Illustration inspired from Shove et al. (2012).

action that can still be understood and identified without the performance of the practice (Svennevik, 2022). This enables the practice to exist and persist over time and space (Speck & Hasselkuss, 2015). They are 'institutionalized' social practices that can be reproduced by a large number of actors in a social system. In other words, here the practice is an entity, a thing in itself, with its own characteristics, properties, and rules. It are the intangible aspects of a practice with established beliefs, norms, and values, within specific broader social, cultural, and institutional contexts, that shape it. Therefore, it is not tied to any particular individual or group of people, but rather exists independently of them; it can be performed by different people as long as they follow the same rules and principles that define that practice. In the words of Watson (2012) "as an entity, a practice is in some sense transcendent of individual incidences of its doing" (p. 489).

'Playing soccer' can be seen as practice-as-entity. Within this practice, there are established rules, regulations, and techniques that are recognized within the sport of soccer. Hence, this practice is to a large extent standardized, and the rules and beliefs are followed by players and teams that participate in the sport. For example, it is universally agreed and followed that you may not touch the ball with your hands, except the keeper, or that players who score a lot are good attackers. Hence, the practice of 'playing soccer' is not necessarily dependent on individual performance, but rather on the established practices that are recognized and followed in a certain pattern by the practitioners. Nonetheless, a practice-as-entity can still expand, contract, and change when they "acquire and lose variously faithful cohorts of carriers" (Shove et al., 2012).

Practice-as-performance

Although practices exist as certain entities that are comprised of a complex pattern of different elements and actions, simultaneously, practices exist as performances. Shove et al. (2012) describe this as: "it is through performance, through the immediacy of doing, that the 'pattern' provided by the practice-as-an-entity is filled out and reproduced" (p. 7). In the words of Kuijer (2014): "the

practice-as-entity is dependent on repeated performances to remain alive" (p. 29). Hence, the perspective of practice-as-performance describes the carrying out or actual performance of a practice in a precise moment in time and space.

It is the tangible and observable actions, that require different skills, knowledge, and competences to perform the practices (Reckwitz, 2002). This makes it possible to "identify the space- and time-specific aspects involved in the production and reproduction of practices" (Svennevik, 2022, p. 166). Consequently, this perspective focuses on the individual and collective actions and behaviors that establish the performance of a practice. Here, practices are shaped and re-shaped through the ongoing performance of individuals and groups, and they are not seen as static or fixed entities. While different people may perform the same practice (as an entity), their individual performances may vary depending on their skills, knowledge, available materials, and the specific context in which they are performing the practice.

Within the example of the practice of 'playing soccer', the actual doing or performing of soccer consists of a complex combination of the elements. However, different players in different positions, such as defenders and attackers, might use different strategies, techniques, and competences based on their roles and responsibilities within the practice of playing soccer. Thus, they perform the practice in real-time differently. This emphasizes the dynamic and situational nature of a practice, where performances may vary depending on the context, time, and the individuals involved.

3.2.3 How do practices change?

As described before, the continued existence or decrease of practices is through the circulation of the three elements, and the links between them, that recruit the practitioner to carry out the practice (Maller, 2015). According to Shove et al. (2012), "it is only through successive moments of performance that the interdependencies between elements which constitute the practice-as-entity are sustained over time" (p. 7). Hence, a practice only exists and can continue to do so if it is continually being performed, in which time and again a

reproduction of the interdependencies between the elements of the practice is sustained.

Through the accumulation of different performances, although a single moment of a new performance is incremental, the entity of a practice itself shifts over time and across space. In other words, if links between the elements are being created or broken down, practices change, shape, or disappear (Shove et al., 2012). Thus, social practice theory recognizes that practices are not fixed entities, but rather they are socially constructed and can be transformed through social, cultural and technological changes.

As mentioned, multiple scholars argue that through the distinctions made between practice-as-entity and practice-as-performance, the theory is well suited for empirical application and to investigate practice changes over time. (Shove et al., 2012) suggest that dynamic and recursive links between the two perspectives of practices is effective to show how innovation in practices occurs. This dynamic and recursive process can lead to long-lasting changes at the level of practice-as-entity. Maller (2015) describes a similar use with the theory as she states that this distinction makes it “possible to speculate about the trajectories of practice change and how to intervene in them” (p. 63). She further argues that through this distinction it is not only possible to investigate practices historically, but that predictions can be made about their future pathways.

Although multiple mechanisms exist in which practices can change (Shove et al., 2012), Watson (2012) uses a “systems-of-practice approach” to identify three mechanisms of practices change: 1) when the elements change, 2) when the people (practitioners) change and 3) when elements and people relate to changes in other practices. According to him, system changes, due to a change in practices, can be explained from this practice-based perspective.

When the elements change

If practices exist only when the three elements are sustained during the performance of the practice, then if the elements change, so will the practice itself. According to Watson (2012) it is

distinct in the processes of technological development. He states that practices of both cycling and driving are recognizable as upcoming practices due to technological development: “both driving and cycling as distinct practices have relatively recent historical beginnings with the emergence of the technologies which define them.” (p. 490). However, he continues, “elements of meaning and of competence can also be sources of dynamism as they are freshly integrated into performances of the practice” (Watson, 2012, p. 490).

When the people (practitioners) change

Although people are being decentralised from analysis within social practice theory, they still play a central role as practitioners. According to Watson (2012) it is “necessary to recognise people and their unique capacities and active involvement in the dynamics of practices”. This is because the performance by the practitioner is necessary to sustain a practice. Hence, “a practice depends upon its success in recruiting practitioners able and willing to do the work of integration entailed in performance” (Watson, 2012, p. 491). If thus the people change, as the practitioners, so do the practices. From this view, practices are likely to evolve gradually as practitioners develop new skills. These practitioners thus follow a path from novice to expert. Practice changes and the rise of new practices can, however, come from both. For example, new techniques can arise from the embodied experience of experts when performances are constantly redefined (Shove et al., 2012). In other settings however, “it is novices who bring new ways of doing into being” (Shove et al., 2012, p. 72).

Kuijer (2014) makes an acute observation as she states that: “the notion that practices can only exist when regularly performed by people and the fact that they are socially shared entities implies that for any practice to exist, a certain number of practitioners is required. It does not mean, however, that this is a fixed and constant group of people.” (p. 32)

When elements and people relate to changes in other practices

If practices are recognized as dynamic entities that evolve gradually as practitioners develop new skills, as new materials or meanings are circulated throughout society, then they can also evolve when other connected practices evolve and change. Watson (2012) states this as how “one practice bundles together with others”. The bundling has an important role in modifying both the elements of practices and the recruitment processes. (Watson, 2012).

Practice bundles refer to sets of practices that are interlinked and mutually dependent. They are groups of practices that are interdependent and mutually reinforcing, and that together constitute a larger (societal) practice. This connection also means that changes in one practice can have ripple effects on other practices within the bundle. An example of a bundled practice is commuting to work by car. This practice includes several elements that are often done together, such as driving, finding parking, and listening to the radio. These elements are interrelated and depend on each other. Changing one element, such as switching to public transportation, would require changes to the other elements as well.

Shove et al. (2012) further create a differentiation between ‘bundles’ and ‘complexes’. According to them, “bundles are loose-knit patterns based on the co-location and co-existence of practices”, while “complexes represent stickier and more integrated combinations, some so dense that they constitute new entities in their own right” (p. 81).

To conclude, interventions aimed at changing practices can take different forms, including “recrafting” specific elements of the practice, substituting one practice for another in a particular sequence or location, or changing the way in which the elements interlock or connect with each other (Nash et al., 2017, p. 15).

3.3 Concluding chapter 3

In conclusion, this chapter delves into the theoretical framework that underpins the research, focusing on the adoption of social practice theory (SPT). SPT offers a valuable lens for understanding

practices involved in the context of the supply processes for CBHs, and for developing interventions to actively develop and reinforce factors that support these processes. The implications of SPT for interventions are thus aimed at promoting reusing activities within the supply processes.

The adoption of this framework is based on its ability to grasp the dynamics of practices within socio-technical systems and their role in driving change. SPT is useful since it shifts the focus away from individual choice and behavior and acknowledges that practices are socially, institutionally, and infrastructurally configured. Hence, this lens is not merely focusing on changing attitudes and behaviors (Shove, 2010), but on the re-organization or re-arrangement of the broader context of which practice are performed. As such, SPT helps to focus on changing the social and material context in which practices occur.

These practices exist as both entities and performances, where the former represents stable patterns and the latter signifies the actual enactment (doing) of practices (Shove et al., 2012; Shove & Pantzar, 2007). As such, SPT can help not just attempting to change a specific performance of a practice, but to pursue broader societal shifts in the organization, understandings, and/or performances of the involved practices as recognizable entities (Nash et al., 2017). This research aims to support practice reconfiguration and eventual re-institutionalization on the level of practices-as-entities.

In the following chapter, that outlines the conceptual framework, the SPT lens will be conceptualized into practical instruments to help apply SPT for this research.

To conclude, this theoretical lens promises to provide a comprehensive perspective on the mechanisms of the supply processes within CBHs. By adopting SPT, this research aims to uncover insights that can contribute to the scaling up of CBH's practices and enhance the reuse of secondary building components.

4. CONCEPTUAL FRAMEWORK

4.1 Introduction

This chapter outlines the conceptual framework that is composed for this research. It elaborates both the notion of the hypothesized supply processes from the introduction and social practice theory from the theoretical framework into an applicable framework. Therefore, first the operational secondary building component supply processes (supply processes) for circular building hubs (CBHs) are conceptualized. Hereafter, social practice theory is conceptualized to be applicable for this research.

4.2 Conceptualizing the supply processes

4.2.1 Introduction

Analyzing both scientific and grey literature in the introduction, the current state and mechanisms of the concept of circular building hubs (CHBs) in the Netherlands have been analyzed and a definition of these hubs for this research is established. Furthermore, the supply processes have been identified. To further determine these supply processes, as such that they can be qualitatively assessed and analyzed, they have to be further specified and outlined within this conceptual framework. In the following paragraph, this will be conducted. Similar to the definition of the CBH, these defined supply processes will be used to operate as a baseline and reference to which the supply processes and involved practices are examined and evaluated.

4.2.2 Definition of the identified supply processes

Below, the preliminarily identified supply processes are being further specified and outlined.

Supply process: Inventory

Inventory is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in the activities evaluating, calculating, measuring and estimating the building components in the existing stock of building structures in terms of quantities, qualities and components characteristics. Hence, this phase is in the beginning of the supply process before any building components are being removed from these building structures. The outcome of the process is the knowledge of these described factors. Neither the materials or knowledge used, nor the activities of how and from where to execute this inventory is further defined. Examples executing this inventory are: measuring the length of building components, counting the quantities of them and making a list of all the building components. These activities can be performed either with or without tools. The inventory phase can only take place on the disassembling site.

Supply process: Collecting

Collecting is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in activities of removing/ disassembling building components from the existing stock of building structures in such a way that they can be reused. Hence, this phase is in the beginning of the supply process after inventory. After removal, the secondary building components are brought to a certain collecting place on the disassembling site which is also part of this process phase. Neither the material types and secondary building component dimensions nor the activities of removing them and bringing them to a certain collecting place, or the collecting place itself, is further defined. Examples of removing/ disassembling building components are: carrying or lifting out, pulling loose, unscrewing, or breaking down. These activities can be performed either with or without tools. The collecting phase can only take place on the disassembling site.

Supply process: Transporting

Transporting is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved

in activities from loading secondary building components in a transportation device, bringing secondary building components from a disassembling site to a CBH or other temporary location, and unloading secondary building components from a transportation device. Neither the building component dimensions nor the transportation devices or methods are further defined. Examples of transportation methods refer to walking, biking, and driving (e.g. by car, bus, or truck with or without a container). Transporting always takes place from the disassembling site to the CBH. A third place where the building components are temporary, for example, to be sorted or repaired, can also be part of the chain. If this is the case, two separate transporting processes are involved.

Supply process: Sorting

Sorting is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in activities of sorting out (e.g. separating, taking parts of, or dividing) secondary building components into different groups. The material types, the volume of the groups, the quantities of building components within each group, which tools and materials are required for those activities, or how the sorting takes place are not further defined. Sorting can take place on the disassembling site, at the CBH, or another location. Sorting can take place multiple times, for example, when rough and quick sorting takes place at the disassembling site and another more thoroughly one at the CBH. If this is the case, two separate sorting processes are involved. Finally, Sorting might have a large overlap with the supply process of inspecting, since both processes can be conducted nearly simultaneously.

Supply process: Inspecting

Inspecting is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in activities of inspecting secondary building components to understand their condition and to know what to do next with each component. The understanding of what to do with each building component revolves around either: throwing it away, repairing it, refurbishing it, remanufacturing it, or preparing it for

reuse, repurposing, or storage. Inspecting is not further defined. Examples of inspecting secondary building components are studying it (up close or from a distance), feeling, twitching, pulling, carrying out material strength measurements with or without tools, or using scanning devices to measure certain material properties. Inspecting can take place on the disassembling site, at the CBH, or another location. Inspecting can take place multiple times. For example when rough and quick inspecting takes place at the disassembling site and another more thoroughly one at the CBH. If this is the case, two separate sorting processes are involved. Finally, inspecting might have a large overlap with the supply process of Sorting, since both processes can be conducted nearly simultaneously.

Supply process: Repairing

Repairing is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in the activities of repairing secondary building components. Repairing is the fixing or mending (the amendment of) of a component that is suffering from damage or a fault, without changing the function of the component (Schut et al., 2015). Minor modifications of a certain component are possible. Repairing is not further defined, and neither are the materials or tools needed for the reparation of the components. Repairing can take place at the CBH or another location. CBHs do not require to involve these processes, since secondary building components can also be reused directly without this process. Direct reuse in this research refers to reusing without the need for repair, refurbish, or remanufacture, but wherein other aspects of the CBH's are still involved. On the other hand, the repairing of a secondary building component can be conducted in the same supply process sequence with refurbishing or remanufacturing.

Supply process: Refurbishing

Refurbishing is a supply process wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in the activities of refurbishing a secondary building component, to be used for the same function as it

did in the original secondary building component (Charfalkar et al., 2016; Johnson & McCarthy, 2014). Refurbishing focuses on repairing and restoring secondary building components to their original or close-to-original condition, but do not have to match in quality or aesthetic looks as a similar new component. Refurbishing is the rebuilding, repairing, restoring or replacing of broken (sub-) components to match the specifications of the original secondary (sub-)component. The refurbished sub-components should be used for the same function as they did in the original secondary building component, but do not have to match in quality or aesthetic looks as a similar new sub-component. Either reused parts, repaired parts or new parts, or a combination of these, are being used for the refurbishing process. An example is a door as a building component which includes a broken door handle. If the door handle as a sub-component is entirely replaced with a new or reused other door handle, and the whole door can perform its original function again, then the whole door as a building component is refurbished. The difference with repairing is that the door handle was not repaired, but the entire handle is replaced. Neither the material types nor the activities of disassembling and putting together parts of sub-components or repairing and restoring are further defined. Examples of refurbishing (parts of) building components are: sanding or polishing, replacing, painting with either hands or tools. Examples of putting together parts of components are stitching, screwing, or gluing parts together. Refurbishing can take place at the CBH or another location. CBHs do not require to involve this processes, since secondary building components can also be reused directly without this process. Refurbishing of a secondary building component cannot be performed in one supply process sequence with remanufacturing, since it is either one of the two that is being performed.

Supply process: Remanufacturing

Remanufacturing is a supply process wherein practices take place that refer to all activities and tasks that are carried out and are directly involved in activities of remanufacturing a secondary building component to be 1) used for the same function as

it did as the original building component (Charfalkar et al., 2016; Johnson & McCarthy, 2014), or 2) to have an entirely new function. In the first scenario, the components may be upgraded or modified to meet current standards or specifications and thus is in a new like state or even one with a higher performance level (Seitz & Wells, 2006). Hence, remanufacturing is a more thorough and costly process than refurbishing, because it is more rigorous and works toward a higher standard (Vecmar, n.d.). In this scenario, remanufacturing is rebuilding, repairing, or replacing sub-components to match at least the specifications of the original manufactured component. It also requires the repair or replacement of worn-out or obsolete parts and segments. The remanufactured components should at least match the same quality and aesthetic looks as a similar new component. Either reused parts, repaired parts or new parts, or a combination of these, are being used for the remanufacturing process. An example again with the door as a building component which includes a broken door handle: If the door handles as a sub-component is replaced for a new or reused other door handle, and also the entire door is sandpapered and painted since some other worn out marks were visible and thus the entire door as a building component is 'as good as new' then it is remanufactured. In the second scenario, secondary building components are being modified as such that they have a new function. Neither the material types nor the activities of disassembling and putting together parts of sub-components, repairing and restoring, or making it into a new component type are further defined. Examples of putting together parts of components are stitching, screwing, or gluing parts together. Remanufacturing can take place at the CBH or another location. CBHs do not require to involve this processes, since secondary building components can also be reused directly without this process. Remanufacturing of a secondary building component cannot be performed in one supply process sequence with refurbishing, since in is either of the two that is being performed.

Supply process: Preparing

Preparing is a supply process step wherein practices take place that refer to all activities and

tasks that are carried out that are directly involved in the activities of preparing the secondary building components to either get stored, reused, or used for repurposing purposes at the disassembling sites. Preparing refers to preparation for dividing the components in certain quantities, labeling the components, registering the components, packing or binding the components, relocating to the storage space, or loading the components for a certain transportation method (bike, car, bus, or truck with or without container, etc.). How these activities of preparing are carried out and which tools and materials are required for those activities are not further defined. Preparing happens after the processes of inventory, collecting, transporting, sorting, inspecting, and when necessary repairing, refurbishing and remanufacturing have been carried out. Preparing the secondary building components always refers to preparing them at the CBH's location.

Supply process: Storing

Storing is a supply process step wherein practices take place that refer to all activities and tasks that are carried out that are directly involved in activities of moving secondary building components from a place at either the CBH or at another location (but not a disassembling site), after the processes of inventory, collecting, transporting, sorting, inspecting and preparing and when necessary repairing, refurbishing and remanufacturing have been carried out, to a place (either indoors or outdoors) where the secondary building components are meant to remain for a certain period. Hence, this is the last phase in the supply process. How the components are being brought/transported there and how they are being stored are not further defined. Examples of transporting secondary building components to the storing place are tilting with bare hands, using a lift forklift or truck, and using a wheelbarrow. Examples of how they are being stored are troughing on a pile, stacking, loading on shelves or in a crate or just placing them somewhere. Storing of the secondary

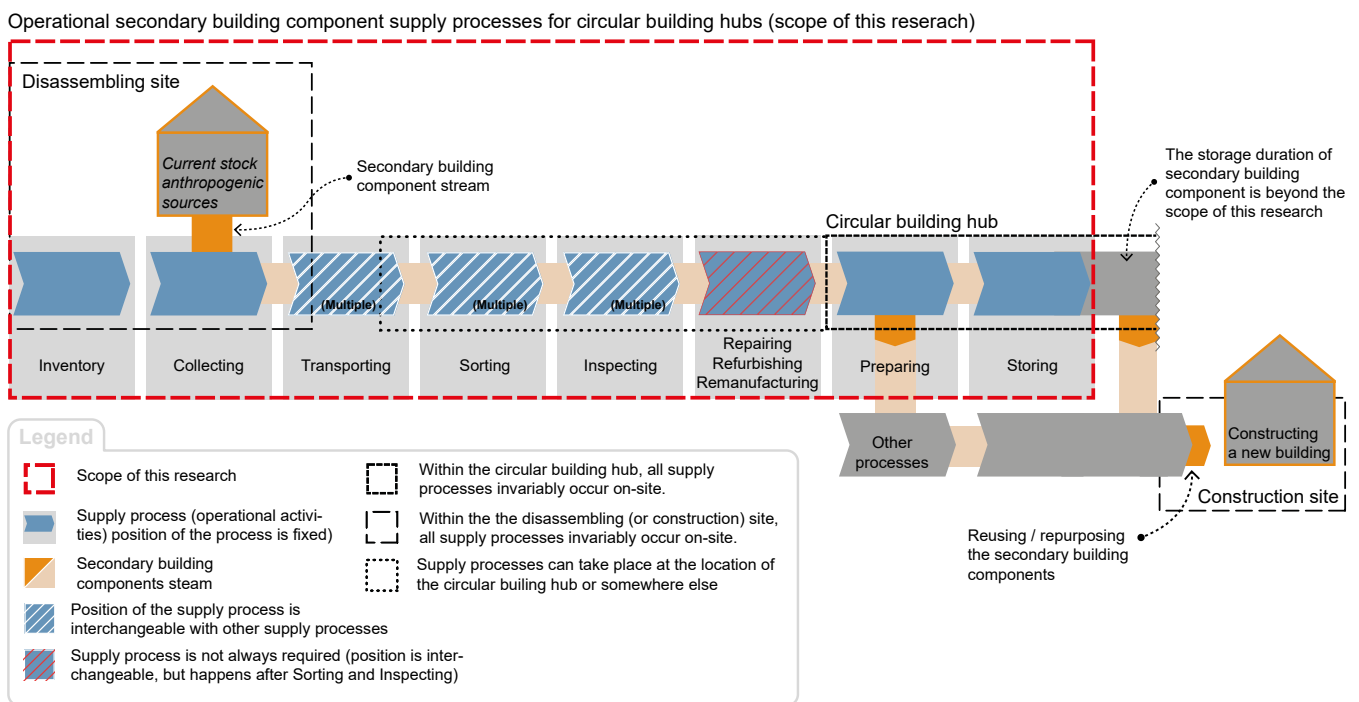


Figure 4-1: Illustrative overview of all the hypothesized secondary building component supply processes and whether their positions within the supply process are fixed, interchangeable with other supply processes an/or not always required during the supply process.

building components always refers to the storage of the components at the CBH's location. No limitations are set as to how long the components are stored.

4.2.3 Overview of the supply processes

The established definitions of the identified supply processes in the previous paragraph function as indicators and provide a conceptual outline to be further qualitatively assessed and analyzed. These have been outlined in an overview that can be utilized throughout this research (see Figure 4-1 on page 30). However, it should be noted that it is an assumption that:

- ✂ the processes of sorting and inspecting can be interchangeable and practices involved might have a large overlap;
- ✂ the processes of sorting and inspecting might take place multiple times in different positions in the supply process;
- ✂ the process of transporting might take place multiple times in different positions in the supply process, but always takes place between the disassembling site and the CBH with possibly a third place in between;
- ✂ the processes of repairing, refurbishing, and remanufacturing have a fixed position after sorting and inspecting. Moreover, that these processes are most likely not all being conducted in one supply process sequence, but that repairing can be conducted in the same sequence with refurbishing or remanufacturing and that the latter two cannot be performed both in one supply process sequence.

4.3 Conceptualizing social practice theory

4.3.1 Introduction

Although in recent years most attention regarding the use of Social Practice Theory (SPT) has been given to consumer behavior (Speck & Hasselkuss, 2015), SPT has been proven useful at an

organizational level such as production processes and with system change research (Svennevik, 2022; Svennevik et al., 2020). Some authors argue that SPT has perhaps great potential in the work on sustainability transitions (Koehler et al., 2017). Moreover, according to Maller (2015), through the distinction between practice-as-entity and practice-as-performance, "social practices can offer explanations of the outcomes of any social problem" (p. 61). However, research indicates that there is no prevailing method for applying SPT (Svennevik, 2022), especially outside consumer behavior. Therefore, in this chapter a concrete conceptualization is established to help apply SPT for this research.

4.3.2 Practices

A practice within the scope of this research is a performance of a routinized doing: an activity, that is configured by three elements: materials, meanings, and competencies. These elements are linked by individuals (the practitioner) when carrying out a practice.

Materials refer to all physical aspects of the performance of a practice. This includes things, technologies, tangible physical entities, and the stuff of which objects are made (Shove et al., 2012), and thus also includes the body of the practitioner (Holtz, 2014). Meanings refer to the symbolic meanings, ideas, intentions or motivations, emotions, and aims of the practice (Holtz, 2014; Shove et al., 2012). Competences refer to skills, knowledge, and techniques that are required to perform the practice (Shove et al., 2012).

Practice

Illustrated for this research

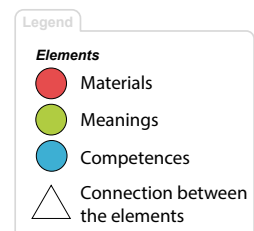
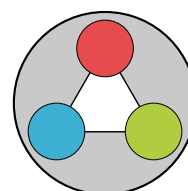


Figure 4-2: Legend overview of the different element composing an practices for this research.

A practice includes sequences of different bodily activities, although the exact arrangement and the scope and scale of these activities are not predetermined. In a process involving the practitioner and different elements, linkages can be made to compose a practice; which is always a certain configuration consisting of all three elements.

4.3.3 Bodily activities

Practices are not bound to a specific number of bodily activities or the locations where these activities take place. However, they are defined by the collective goal that these individual activities pursue and their arrangement in a time and space-organized sequences to achieve that goal. Hence, all bodily activities in one practice are dependent on each other to achieve their collective goal.

An example of a practice that has a sequence of different bodily activities that all pursue the same goal is: 'packing secondary building components' (for transportation). This practice may include the bodily activities of 1) opening the truck, 2) unloading carriages, 3) packing secondary building components onto carriages, 4) packing the carriages into the truck, and 5) closing the truck. Other bodily activities can be integrated somewhere in this sequence. For example, if one extra activity is added between 4 and 5, such as binding the carriages to the walls of the truck, then the shared outcome can still be achieved.

Although each bodily activity has its own smaller goal, the specific time and space organized sequence of these bodily activities makes that their collective goal is to pack the building components into the truck. This makes that they all belong to the same practice. Moreover, these individual bodily activities must occur in a certain time and space orderly sequence for them to share and achieve both their individual and common goal. Hence, these bodily activities are interdependent and cannot be easily separated from each other. Moreover, they are so closely connected that changing one within the sequence, could require changes to (all) others as well. For example, without opening the truck first, other bodily activities such as packing the carriages into the truck cannot be performed.

4.3.4 Differentiate between practices and bodily activities

To differentiate between different practices derived from many distinct bodily activities performed in one sequence, a set of conceptual sequence rules is proposed. These rules help determine where one practice ends and the next one begins.

Such practical boundaries are the points where there is a noticeable shift in the bodily activities, and/or competences of the bodily activities and/or a shift in the context wherein these activities are conducted. The rules are used as criteria from which it can be determined that such sequences of bodily activities can be separated into different groups; and thus in different practices. Likewise, these rules help differentiate between different bundles of practices. The exact scope and scale of bodily activities are not described. Hence, it could be a specific action, belief, or context that marks the transition from one practice to another.

The conceptual rules for bodily activities are the following:

- ⌘ Activities and actions: There is a distinct change in the types of bodily activities or actions being performed. These activities have distinct (sub)goals and can be separated into different sets (no minimum or maximum of bodily activities in one set or practice is required).
- ⌘ Contextual indications: There is a contextual change that might indicate a shift in the purpose or focus of the bodily activities, such as changes in the physical environment or the spatial arrangements of that environment.
- ⌘ Material changes: There is a change in (the use of) material objects that indicates a shift in the purpose or focus of the bodily activities, such as the use of specific tools or physical objects.
- ⌘ Goals and intentions: There are distinct changes in the goals or intentions of the individuals or groups involved, such as the purpose or desired outcome of the bodily activities being changed.

⌘ Temporal gaps: There is a significant gap in time between bodily activities or differences in timely performances. For example, there is a substantial time gap between two sets of activities or a change in the pace of actions.

Figure 4-3 on page 33, shows a flowchart that is utilized to determine whether a sequences of bodily activities can be separated into different practices. First it is necessary to thoroughly understand and formulate diverse bodily activities from the data. Than, the flowchart is used in the following manner:

1. Starting at the 'Start' arrow, the flowchart asks whether there are differences

between the bodily activities in terms of specific actions performed, beliefs, or the context where the activities are performed.

2. Fictionally answering these with either 'yes' or 'no' will eventually lead the user of the flowchart to one of the two outcomes: 1) A new practice is performed, or 2) It is still the same practice.

Although in this research, a practice has no sharply-defined boundaries, a practice and thus also the sequence of bodily activities that reside in it, can never exceed the borders of a specified supply processes. An example is the practice of 'unloading secondary building components'. This practice may

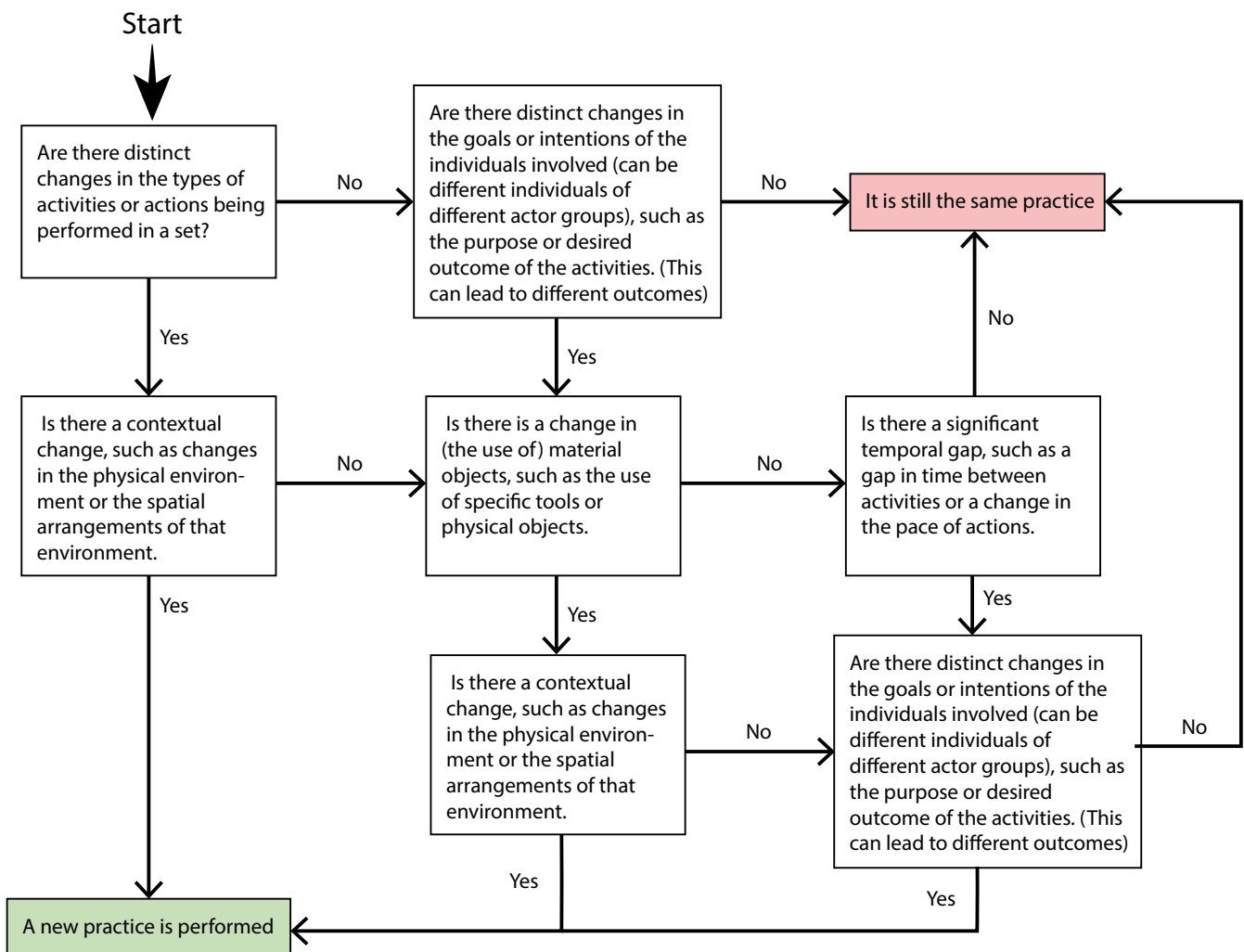


Figure 4-3: Flowchart of the conceptual rules for the bodily activities. This flowchart is utilized to determine whether a sequences of bodily activities can be separated into different practices.

include the sequences of bodily activities of driving the truck to a designated area in the CBH, opening the truck, unloading the carriages, unpacking secondary building components from the carriages, and piling them in a corner. However, separating the different components on different piles is within the borders of the supply process of 'sorting'. Hence, here a new practice is performed. However, it should be noted that these practices are very closely intertwined and minor changes in the bodily activities performed can be the outcome of where one practice starts and the next begins. Henceforth, it is important to specifically argue where certain practices end and others begin.

4.3.5 Practice Bundles

In certain situations, multiple practices are performed in one fluid and coordinated sequence. If this is the case, than those practices can potentially be seen as a practice bundle (Shove et al., 2012). For this research, a bundle of practices refers to a group of practices that are interrelated and persist as close-knitted pattern based on the co-location and co-existence of one another. Hence, a practice

bundle consists of a collection of related practices that are regularly and routinely, but not necessarily, performed in conjunction with each other. For example, unloading the secondary building components and inspecting these components can easily be performed in a one fluid and coordinated sequence.

Individual supply processes could potentially be occupied by multiple practices and multiple bundles of practices. Moreover, practice bundles can potentially exceed the borders of these supply processes. In other words, a practice of one supply process can form a bundle with a practice within the next supply process.

The (strong) connection between multiple practices within a bundle means that changes in one individual practice within this bundle can have strong ripple effects on other practices within the same bundle. As such, examining whether practice bundles can be established can potentially reveal interesting insights.

To conclude, multiple practices that are performed in a one fluid and coordinated sequence

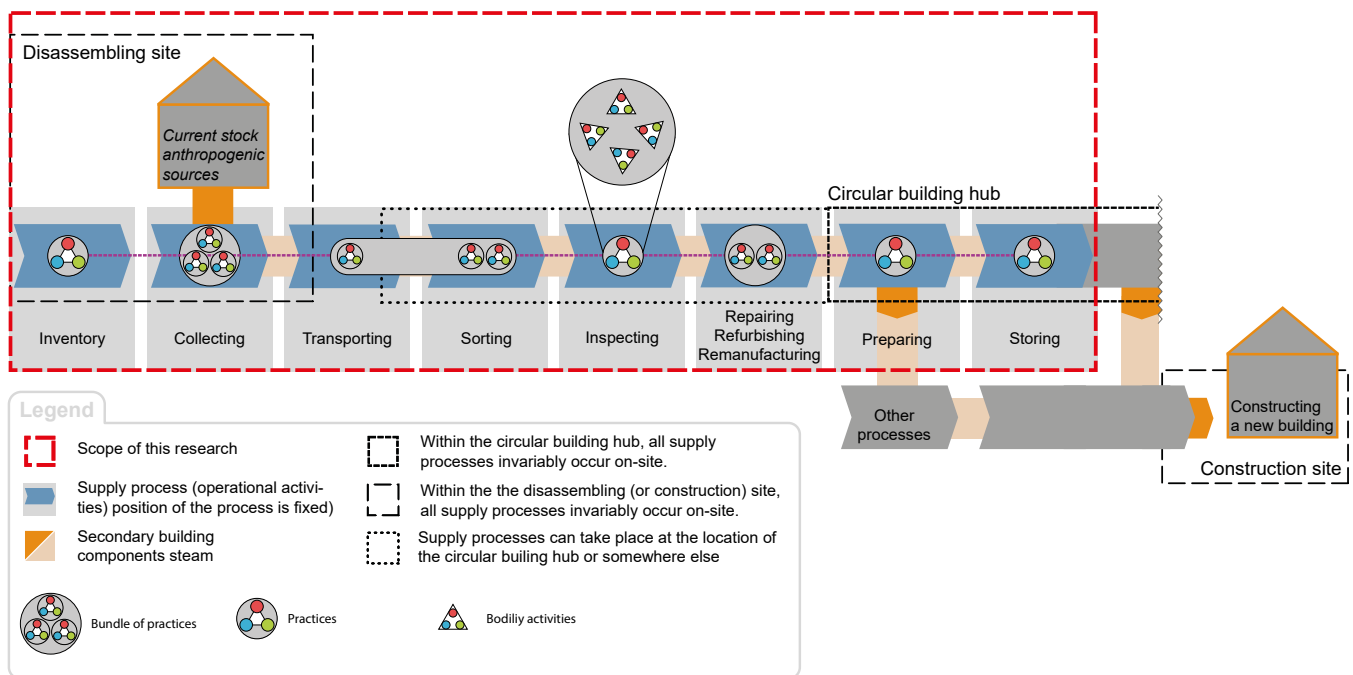


Figure 4-4: Illustrative overview of the different practices and practice bundles existing within the supply process.

and that are regularly, but not necessarily, performed in conjunction with each other, are considered as practice bundles within this research.

4.3.6 The practitioners

Practitioners from different actor groups can both perform the same bodily activities that form a practice. Depending on their motivation however, the performances of these practices can result in one or two different practices.

Although people are being decentralized from analysis within SPT, they still play a central role as practitioners. For this research, the practitioner is considered to be a vessel in which competence and meaning elements are (partially) embedded and can evolve. In a process involving the vessel and material element(s), linkages can be made to compose a practice; which is always a certain configuration consisting of all three elements.

Different practitioners from different actor groups (e.g. transport company, refurbishing company, CBH company, local government agencies) can still perform the same practice; from the perspective of a practice-as-entity. The practitioners performing the practices are motivated to perform them on a work-related basis. Hence, the business models and thus the drive for a certain outcome, which shape the element 'meanings' of the performed practice, from which each actor group operates, might be different. When this differentiation also leads to a different outcome, then they are perceived as two separate practices. For example, the practice of 'disassembling secondary building components' performed by an actor of the demolition company is most likely different from the same practice performed by an actor of a CBH company, even though the same sequences of bodily activities are involved. To explain, the business model, and thus the drive for inspecting the secondary building components, from the demolition company could be to get rid of the components as quickly as possible. Though the business model for the CBH company could be to have a large stock of reusable components with high quality. This can result in different meanings of why the components must be disassembled and can therefore also result in different quantities

and qualities of the building components they end up with. Hence, in this example the practices are different.

4.3.7 Practices directly outside the supply processes

As explained before, this research focuses on the practices involved in the supply processes. However, these practices are possibly being motivated or shaped and are closely interwoven with other practices directly outside these processes. It is important to examine all the practices since, according to Maller (2015), a study of one practice in isolation from the others with which it intersects is likely to be limited in its power to explain a current issue or social problem, as well as providing a limited basis on which to design for intervention and change" (p. 59). Therefore, these practices directly outside the supply processes, that have a direct influencing link with the practices within these processes, are also included into the scope of this research (See figure Figure 4-5 on page 36).

An example is the following practice: 'planning the appropriate time'. This practice has a direct influence on the practices within the supply process, for example, the time that is provided for the practice of 'sorting secondary components'. However, this practice can be categorized under an administrative process that thus remains outside the operational supply processes. Nonetheless, without the knowledge of this practice, the study is likely limited in its power to explain the deeper understandings and issues associated with the involved practices. Finally, ripple effects due to changes in certain practices that can spill over and have a similar effect on other practices in connecting supply processes, can also spill over to practices directly outside the supply processes. To conclude, all practices within the supply process and directly outside the supply processes, that have a direct (meaningful) influencing link with the practices within these processes, are taken into account.

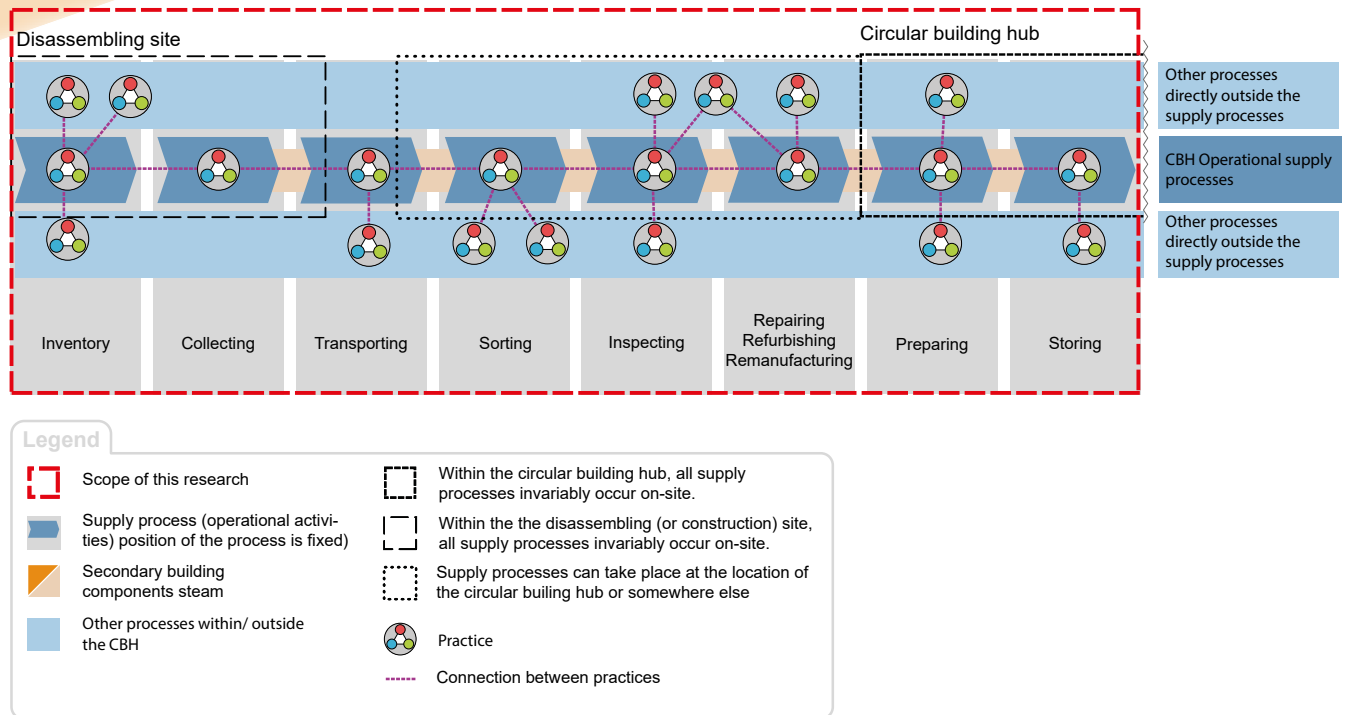


Figure 4-5: Illustrative overview of where practices can reside: Embedded within, or directly outside the supply processes, both within and outside the CBH or outside the CBH. Also visualizing the connection that practices can have.

4.3.8 Observing performances, changing entities, creating generalized transferables

The observable and tangible performance of an actual practice in a precise moment in time and space is always a practice-as-performance (Reckwitz, 2002). This is because practitioners “do the active work of integrating the elements of the practice into a contingently effective configuration, in the process of doing” (Watson, 2012, p. 490). Therefore, the elements and bodily activities that are being observed and identified, will always entail space- and time-specific aspects involved in the production of the practice at hand (Svennevik, 2022). Thus, as Watson (2012) states: “if theories of practice saw the performance as perfectly scripted by the pattern of practice as entity, their credibility would crumble as soon as they were confronted with empirical reality” (p. 490). In other words, the practices observed can never contain all the elements and their specific arrangements associated with the practice-as-entity. Accordingly, to

be able to gain a deeper and more comprehensive understanding of the practices-as-entities involved in the supply processes of CBHs, the practice-as-performances must first be understood.

Likewise, practice-as-performances are important to analyze since it is here that the performance can involve elements of “spontaneity and innovation as well as routine and habit”, although innovations in a single moment of performance are always gradual (Watson, 2012, p. 490). Analyzing diverse practice-as-performances that try to accomplish the same outcome, can thus potentially reveal the historical trajectory over time of the practice. Consequently, one can make predictions about its future path. Moreover, observing these moments of spontaneity and innovation can help to map and identify elements that enable or shape changes in practices.

The practices-as-entities only exist through the succession of performances that organizes and establishes them. Although those performances are always potentially unique, it is important to first examine the total entity as different performances,

and understand them separately. Only then the observer can aim to integrate these separate performances to reproduce and theorize about the performativity of what is now known as the entity of the observed practices. Important within this research is thus to render diverse practice-as-performances that try to accomplish the same outcome and translate them as a practice-as-entity.

The practice-as-entity is more than just the sum of almost identical performances. For example, the practice-as-entity not only entails diverse performances of a single practice, such as inspecting different types of secondary wooden building components, but also considers variations in for examples contexts, materials and actors. For example, if in case study A actor X is inspecting timber at the CBH, and in case study B actor Y does this with steel at the disassembling site, this research tries to reveal the similarities between them and extrapolate the elements in one practice-as-entity of 'inspecting secondary building components'.

To conclude, to be able to gain a deeper and more comprehensive understanding of the practices-as-entities involved in the supply processes of CBHs, the practices-as-performances are first examined. These performances are then combined to create the practices-as-entities.

4.3.9 Core practices-as-entities

CBHs have potentially very distinct characteristics and operate under different business models and within different contexts. Because this research focuses on the scalability of practices within these potentially diverse CBHs, it is interestingly to identify more general and core practices-as-entities that can effectively be operationalized in different CBHs. Consequently, this research introduces a categorization of practices-as-entities into two types: 1) practice-as-entity, and 2) core practice-as-entity. It's important to note that practices-as-entities and core practices-as-entities share an essential theoretical similarity. Specifically, a core practice-as-entity is identical with a practice-as-entity, in that it not only entails diverse performances of a single practice, but also considers variations in for example contexts and actors.

Distinguishing practices-as-entities from core practices-as-entities lies in the scope of their applicability. Core practices-as-entities are practices embedded across multiple supply processes in various CBHs. These practices have been verified across these diverse contexts and operate within different business models. 'Core' means that the practices-as-entities are embedded in the core of the whole concept of a CBH. The focus on core practices-as-entities is therefore guided by their adaptability across different CBH contexts. Hence, these core practices-as-entities are central practices that play an key role in CBH's supply processes.

Identifying and understanding these core practices offers valuable insights that can be universally adopted within the CBH concept. Hence, by acknowledging and creating a distinction between these two types, this research aims to provide greater insights that can improve practices across different CBHs within different contexts operating under different business models.

To conclude, this research categorizes two types of practices-as-entities: 1) practices-as-entities and 2) core practices-as-entities. The core practices-as-entities are characterized by their presence in multiple supply processes across different CBHs, which potentially operate under diverse business models. These core practices are considered pivotal practices within the supply processes of the concept of CBHs.

4.4 Concluding chapter 4

In conclusion, this chapter has laid the foundation for the conceptual framework that will guide the following phases of the research. By elaborating both the supply processes and the application of SPT, this chapter establishes a comprehensive structure for analyzing and understanding the dynamics within CBHs. The defined supply processes serve as a baseline for the examination of practices involved in CBHs, while the conceptualization of social practice theory provides a theoretical lens through which these practices can be comprehensively studied. The distinction between practices-as-performances and practices-as-entities, and including the identification of core practices-as-en-

tities, reinforces the adaptability and transferability across diverse supply processes of CBH within different contexts, which potentially operate under diverse business models. Hence, this framework will serve as a roadmap for exploring the involved (core) practices within the supply processes.

5. RESEARCH METHODOLOGY

5.1 Introduction – Type of research

This chapter explains the methodological approach of the exploratory research. This exploratory research (research) adopts a qualitative case study exploratory research approach. It aims to understand which constraining and enabling factors influence the scalability of social practices that support the operational secondary building component supply processes (supply processes) of circular building hubs (CBHs). Hence, this research focuses on meanings, multiple deeper understandings, and the various constraining and enabling factors that influence the involved social practices within a specific context.

Social practices consist of the experiences and perspectives of individuals, comprising elements such as meanings and competences, as viewed from the standpoint of the actors involved (Hammarberg et al., 2016). These phenomena are inherently complex, occurring within specific contexts, and are influenced by numerous complex factors and nuances. Qualitative research is well-suited for the study of these phenomena because it facilitates an in-depth exploration of them (Yasir et al., 2019). Moreover, qualitative research allows for the observation of the practices in their natural settings, an essential aspect that can be integrated into a case study approach (Yin, 2009).

To accomplish a deeper understanding of the empirical data, this research has been developed via a methodological triangulation analysis, which refers to *"the use of multiple methods or data sources in qualitative research to develop a comprehensive understanding of phenomena"* (Carter, 2014, p. 1). Therefore, three different data collection methods and four different data sources (four case studies) have been researched. As such, a more rich data set was collected. Consequently, this allowed to analyze similar supply processes

performed by different actors and analyze the differences between them. Moreover, it allowed for rendering diverse observed practice-as-performances and translating them a practices-as-entities. Finally, due to the pre-established definitions of the supply processes, to authorize which CBHs and supply processes were being elected and evaluated, a danger of a biased perspective regarding what the practices entail was present. Therefore, next to gaining a more comprehensive understanding, an important reason for analyzing four separate supply processes and then utilizing triangulation methodology and verifying the findings, is to limit the possible biased perspective of which and how certain practices are performed and how they relate to the supply processes.

Qualitative research usually involves a theoretical or philosophical framework (Hammarberg et al., 2016, p. 500). Henceforth, the entire research methodology is centered around the conceptual framework which is based upon a Social Practice Theory (SPT) perspective and the established hypothesis of the supply processes of CBH. The conceptual framework functions as the lens through which all data is collected, observed, and analyzed. This enables, for instance, the (repetitive) practices within the supply processes to be made the unit of analysis. An iterative analytical process guided by the conceptual framework will therefore be conducted in all stages of the data collection phases and analyses.

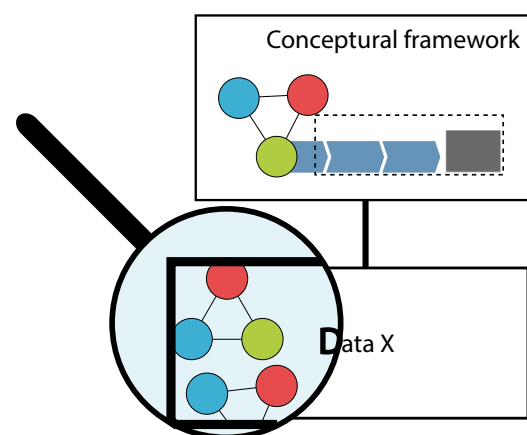


Figure 4-6: Legend overview of the different element composing an practices for this research.

5.2 Selection criteria for the case studies

The hypothesized concept of the CBH and established conceptual definitions of the supply processes have been utilized to operate as a baseline and reference to which CBHs and their supply processes were elected and evaluated. These established conceptual definitions were used to validate the data gathered from the empirical data collection phase. They functioned as indicators against which all empirical data was measured and validated. For the selection of the case studies, however, extra criteria were outlined to further ensure the compatibility and enrichment of the data. These criteria were likewise used to operate as a baseline and reference from which the CBHs were selected and evaluated. The criteria are divided into three groups: One group for the shared criteria to which all case studies were evaluated and two groups for separate criteria that were needed to apply to at least to case study each (See Tabel 5-1 on page 42).

Next to these criteria, there were two conditions specifically left out for this research. This was chosen to enhance the likelihood of finding adequate case studies and to enhance the transferability of the results, both for the development of current and future CBHs.

First, the precise location of the CBH was left undefined. The reason for this was that, although the location of a CBH might be important in terms of some purposes that it facilitates, such as organizing goods flows between parties for fewer transport movements, less congestion, and better air quality in the city or region, this research only examines the practices within the supply processes of building components. Although the location can have effects on these practices, especially in terms of transportation time, these effects can be considered arbitrary in comparison with for example effects from other criteria. Moreover, this could further reduce the possibility of finding adequate case studies, while other criteria were more important. Hence, the likelihood of finding comparable case studies was, therefore, higher when the locations of the CBHs were left undefined.

Second, the material types (e.g. timber, glass, or concrete) that the CBH processes were left undefined. There were multiple reasons for this. First, although the types of materials can have effects on the practices involved, narrowing material types down to certain types would have only further reduced the possibilities of finding comparable case studies. Second, with other criteria such as that CBHs must process building components (and not only raw materials), some restrictions in terms of material types, dimensions, and characteristics were already provided. Finally, from preliminary research, it was understood that many secondary building components and materials do not function well within the business cases of CBHs. For example, toilets are easy to retrieve from disassembling sites, but social

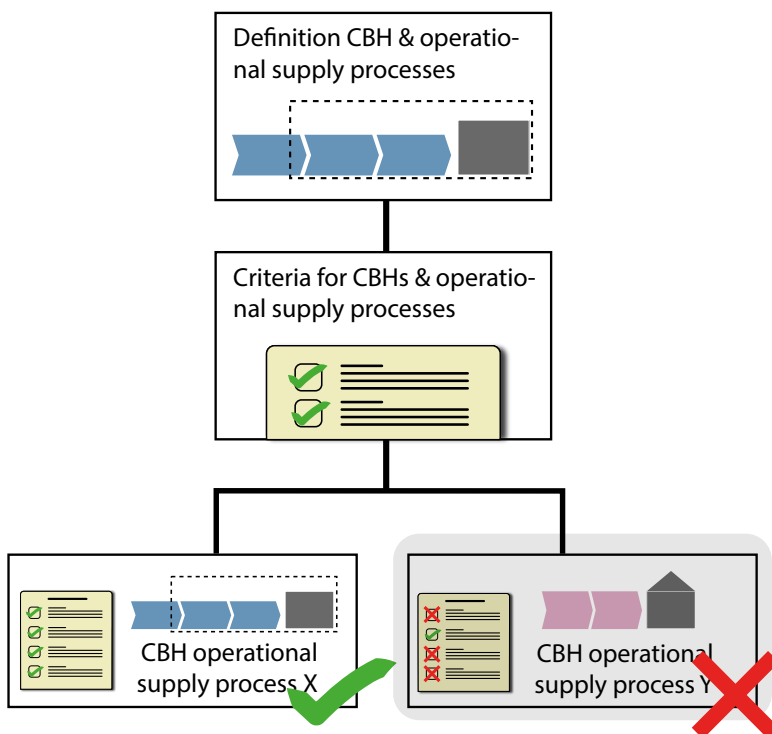


Figure 5-1: Illustration of how the case studies are selected utilizing both the conceptual framework and the selection criteria for the case studies.

factors make it difficult to reuse them (Explorative interview 2, 2023), and materials such as glass are more difficult to process and reuse again because knowledge about their characteristics (e.g. isolation value) is often unknown (Interview 7). Hence, the likelihood of finding comparable case studies was therefore higher when material types were left undefined.

Criteria for all case studies	
Criterion 1:	The circular building hub must work with building components (and not only with raw materials) coming from disassembling sites.
Description:	The selected case studies have to be involved in the processes of reusing building components (either received from business or private parties) derived from disassembling sites, but can include other processes such as raw material recycling (though these other processes are not included in the scope of this research. The reasoning for this is that this research distinguishes between building components and raw materials, but focuses solely on building component reuse through CBHs).
Criterion 2:	The Storing and Preparing supply processes are conducted at the circular building hub and the storage space here must be of adequate size to supply a small to medium-sized construction project.
Description	The selected case studies had to focus on preparing and storing secondary building components at CBH locations, with no specific time constraints on storage. The requirement was to have a sufficient space capable of preparing and storing a specific quantity of at least one type of secondary building component, suitable for a small to medium-sized construction project. The Storing and Preparing processes had to occur within the CBH boundaries, as the research only considered CBHs where building components were brought and circulated within a defined physical location. Preparing and storing processes play a crucial role in realizing CBH functions (e.g., combining new and secondary building component streams and managing supply-demand time differences), while other functions could be carried out at disassembly sites or other locations.
Criterion 3:	The circular building hub must include all supply processes, except for the repairing, refurbishing, and remanufacturing processes.
Description	The selected case studies had to involve all of the pre-established supply processes and conduct practices that could be reviewed within these pre-established processes (see Conceptual framework), except for the processes: of repairing, refurbishing, and remanufacturing. The extensiveness, location (except for those mentioned in Criteria 2), or order of the processes were not predetermined. It was important that the selected case studies involved all the pre-established supply processes for a comprehensive comparison and to better understand constraining and enabling factors.
Criterion 4:	The circular building hub must be located and operated (partially) in the Netherlands.
Description	The selected case studies had to be located in the Netherlands. Likewise, the pre-established supply processes had to at least partially be operating in the Netherlands, since this research focuses on CBHs in the Dutch context.

Criterion for case study/studies option A	
Criterion A1:	Multiple actors are involved in the supply process of the circular building hub.
Description:	For at least one case study, the CBH did not need to carry out all the different pre-established independently. Preferably, some, except for the supply processes of Preparing and Storing, were in collaboration with or entirely performed by other actors.
Reasoning:	From preliminary research, it was understood that not all CBHs conduct all of the different supply processes themselves. Moreover, to make circular building components streams profitable, large quantities are necessary since this is more easily accomplished with multiple actors involved in the supply chain (Nuddekweerd, 2023). Therefore, it was interesting to analyze supply processes with diverse practices performed by different actors and analyze if linkages between them created certain enabling or constraining factors. This was also interesting since coordinating the circulation of reused building components “requires logistic planning and proper communications between local stakeholders” (Ramli, 2020, p. 6). Finally, since there had to be a possibility to store the secondary building components at the CBH’s location, actors from the CBH had to be involved in this supply process.

Criterion for case study/studies option B	
Criterion B1:	One (max. possibly two) actor is involved in all of the pre-established supply process of a circular building hub.
Description:	For at least one case study, the CBH had to conduct all of the different pre-established supply processes independently.
Reasoning:	From preliminary research, it was understood that some CBHs conduct all of the different steps themselves (Interview 7). Hence, it was interesting to analyze similar supply processes that were in one case performed by different actors and in another case performed by one actor and observe differences between them.

Tabel 5-1: Overview of all the selection criteria for the case studies.

5.3 The selected case studies

For this research, four cases were selected. These selected case studies were based on the selection criteria described in the previous paragraph. Specifically, next to these criteria, these case studies were also selected since from preliminary research was understood that they all include an open accessible online Marketplace from which could be observed that they were more mature within their secondary building component reuse compared to other companies.

Case 1: ADEX Groep - Circulair building hub (Utrecht)

The first case study is the CBH of ADEX Groep. ADEX Groep is a Dutch company that operates from multiple places throughout the Netherlands, though their CBH is located in Utrecht. The hub

specifically correlates with the criterium for ‘case study/studies option B’

Since 1992, ADEX Group (formerly Bnext.nl Sloopwerken, and before that Beelen.nl) has transformed from its origins as a demolition company into a “sustainable contractor in the demolition sector, a recycler of construction and demolition waste streams, and a processor of industrial waste” (adex.nl, n.d.-b). As such, they have evolved into a leading force in demolition, dismantling, and disassembly, including its own asbestos and chromium VI remediation branch, with around 200 employees (Interview 7).

Case 2: BORK Groep - Circulair building hub (Hoogeveen)

The second case study is the CBH of BORK Groep. BORK Groep is a Dutch company which operates from multiple places throughout the Neth-

erlands, though their CBH is located in Hoogeveen. The hub specifically correlates with the criterium for 'case study/studies option B'.

The history of the BORK family business traces back to 1946 when the entrepreneur Jan Bork recognized the potential arising from a scarcity of construction materials after World War II. Jan Bork commenced collecting and trading these materials such as timber from the West-Netherlands region (Borkgroep.nl, n.d.). These limited and valuable resources swiftly found receptive buyers among farmers and contractors. As the material supply diminished in the western region of the Netherlands and the market for used materials reduced, BORK strategically shifted its focus towards demolition activities, because: "demolition made it possible to obtain usable material directly from the source" (Borkgroep.nl, n.d.). Consequently, they have evolved into a pioneering company in recycling, demolition, and disassembly, including its own asbestos and chromium VI remediation branch, with around 150 employees. BORK has undergone a progressive transformation into a modern family business. As such, BORK significantly contributes to the recycling and reusing of diverse secondary building components and materials. Although circular is in the 20th century a popular term, BORK was founded on the idea to reuse building components: "As many demolition contractors will confirm, we [demolition companies] have always been circular. This company also originated from a reuse idea and has developed over the years into a large demolition company. [...] The idea of recycling was therefore always there, but with the rise of large hardware stores, recycling has decreased somewhat, mainly because the price-quality ratio has changed completely. So you could get a new beam without nails and splinters. [...] Over the past 5-6 years, we have seen that changes again" (Interview 5).

Case 3: 2dehandbouwmaterialen - Circulair building hub (Oosterhout)

The third case study is the CBH of 2dehandbouwmaterialen. 2dehandbouwmaterialen is a Dutch company that operates from- and is located in Oosterhout. The hub specifically correlates with the criterium for 'case study/studies option A'.

Founded in 2009, 2dehandbouwmaterialen.nl emerged as a company trading both in new and used construction materials. However, in 2021, they decided to separate the trade in new and used (secondary) building components and materials, resulting in the distinct positioning of 2dehandbouwmaterialen.nl. This development was organized as an integral part of the Heezen Bedrijven, a pioneering company in recycling, demolition, and disassembly, including its own asbestos and chromium VI remediation, soil decontamination, and infrastructural works, with more than 300 employees. Heezen Bedrijven, a demolition company under the banner 'M. Heezen', is a family business that traces back to 1956, comprising over 10 subsidiaries that operate nationwide, supplemented by international experience. Over the course of more than 60 years, they: "process waste streams in a high-quality manner through circular processes and strive for maximum value retention and optimal reuse of materials through the use of innovative demolition work." (M.Heezen, n.d.).

Case 4: Hoogeboom - Circulair building hub (Zwolle / Raalte)

The fourth case study is the CBH of Hoogeboom. Hoogeboom is a Dutch company that operates from multiple places throughout the Netherlands, though their CBHs are located in Zwolle, Raalte, and Apeldoorn. The hubs specifically correlate with the 'case study/studies option A'.

Founded in 1935, Hoogeboom emerged when the entrepreneur Gerhard Hoogeboom ignited the family-owned business, first in the agricultural sector. Building upon this foundation, his son Marinus expanded the company's portfolio to encompass contracting, recycling, and equipment rental. Spanning nearly a century, with now the third generation in the lead, Hoogeboom has been at the forefront of diverse domains, such as ground, road, and waterworks, equipment rental, water management, paving, recycling, demolition, and disassembly, including its asbestos remediation, with around 60 employees. The company has strategically established waste and concrete stations across Raalte, Zwolle, Apeldoorn, and Enschede. Hoogeboom has undergone a progressive transformation into a modern family business. As

such, Hoogeboom significantly contributes to the recycling and reusing of diverse secondary building components and materials and started circular demolition nearly three years ago (Hoogeboom.nl, n.d.).

5.4 Data collection methods

The selection of data collection methods was based on the most practical, sensible, and ethical options to be considered, whilst ensuring the reliability and enrichment of the collected data. For this research, three different methods of data collection were used: semi-structured interviews, observations & field notes, and a focus group discussion.

5.4.1 Semi-structured interviews

In total, seven open-questioned and semi-structured interviews were held with relevant stakeholders concerning the supply processes of CBHs (See Tabel 5-4 on page 44; See Appendix H (External) for the transcripts; in the Dutch language). This method was used for three reasons. First, it is one of the most powerful tools for gaining an understanding of human beings and can extract

'rich information about personal experiences and perspectives' (Carter, 2014, p. 1). Second, it allowed for spontaneity, flexibility, and responsiveness to individuals. Third, according to Hitchings (2012), interviews can provide appropriate and fitting data for analyzing social practices, as the author states that 'people can often talk in quite revealing ways about actions they may usually take as a matter of course' (p. 61).

The aim of the semi-structured interviews (interviews) was to develop a comprehensive understanding of the supply processes, the involved actors, and the elements that created the involved practices. Hence, practitioners directly or indirectly involved in these supply processes were being targeted. Only employees from the selected CBHs, working directly and/or indirectly within the operational supply processes, and thus contributing to the development or shaping of practices within these supply processes, were interviewed.

The targeted data in the interviews include opinions and facts about relevant actors involved in the supply processes, the activities involved in the practices, the skills knowledge, and materials required to execute the practices, and the meanings

Overview conducted interviews			
Pseudonym	Organization	Function	Length interview
Interviewee 1	ADEX Groep	General employee (indirectly involved in the supply processes)	0:52:35
Interviewee 2	ADEX Groep	General employee (directly involved in the supply processes)	1:21:49
Interviewee 3	2dehandsbouwmaterialen.nl	General employee (directly involved in the supply processes)	1:04:21
Interviewee 4	2dehandsbouwmaterialen.nl	General employee (directly involved in the operational supply processes)	0:22:59
Interviewee 5	BORK Groep	General employee (indirectly involved in the supply processes)	1:47:11
Interviewee 6	Hoogeboom	General employee (indirectly involved in the supply processes)	1:40:15
Interviewee 7	ADEX Groep	Director employee (indirectly involved in the supply processes)	0:43:35

Tabel 5-4: Overview of the conducted interviews. Including Pseudonym, organization name, function description, and the length of the recorded interview data.

and values associated with the practices. By focusing the questions on such data, a more all-encompassing and comprehensive interpretation of the supply processes, practices, and behaviors involved could be established. The interview questions were slightly different for every stakeholder involved depending on the supply process stages that the interview focused on (See Appendix "Appendix B – Questions list, Semi-structured interviews" op pagina 127 for the questions list; in the Dutch language).

Although the supply processes are divided into ten different stages (inventory, collecting, transporting, sorting, inspecting, preparing, repairing, refurbishing, remanufacturing, and storing), all interviewees from the different case studies were (in) directly involved in multiple processes. This allowed to extract data on all supply processes.

In two case studies, the first interviewee was with someone more indirect (e.g. manager) involved with the supply processes. From there, exponential discriminative snowball sampling, which refers to a method wherein the first participant of the interview provides multiple referrals from which the researcher chooses only those who meet specific criteria to participate (Bhat, 2018), was used to map other individuals within the supply processes.

During the interviews, the questions about the supply processes were asked step by step from one supply process to the next. There were two reasons for this. First, via this method, it was more likely that the sequences of practices in a row were being observed and interlinking practices were not being overlooked. Second, it was a hypothesis that all of the different supply processes were involved within each CBH. Hence, this research had a certain bias in terms of what the supply processes of the CBHs entail and which practices are to be encountered. By asking questions about one supply process and then when all data was collected the next process was discussed, it was more likely that all involved supply processes were being mapped and possibly others were not overlooked or those that were not involved were being searched for.

A possible danger was when certain steps were accidentally overlooked, for example, because the involved interviewees were not aware of them or

simply forgot to tell about these steps, this could create a bias that these steps are not involved at all. To counter this as much as possible, a chart was constructed which was actively maintained during the data collection phase. Moreover, at the beginning and end of each interview, the interviewees were asked to trace back all the steps from the chart and note if there were any missing.

All interviews, except for interview 7, were conducted at the CBH, the workplace of the interviewees. These locations were chosen to encourage the interviewees to mention issues that they regard as being irrelevant parts of their daily work and the mechanisms of the CBH, but could have been relevant for this research. This might occur since "respondents are closer to the venue of actual performance and this proximity enables inclusion of the materiality and daily life being part of the practice" (Svennevik et al., 2020, p. 173).

5.4.2 Observations & Field Notes

With the insights from the interviews, the preliminary insights about the involved social practices within the supply processes were validated and supplemented with observations. Henceforth, four observations were conducted; three at three different CBHs and one at a disassembling site (Tabel 5-5 on page 46). Conducting the observations here provided a deeper understanding of the involved social practices and resulted in a deeper understanding of contextual arrangements such as space and the usage of material objects. The observations were conducted during the normal day-to-day operations. This allowed to observe for the most accurate display of the practices involved.

Since this research aims to find constraining and enabling factors influencing practices in the supply processes of CBHs, only practices involved within these processes were observed. Another reason for conducting observations only at these processes is that doing observations at other processes, for example at the administrative processes, would have been very time-consuming and the extra enrichment of the data would have been only slightly advantageous.

The danger in observations from a staged performance was that relevant parts of their daily

work life could have been deliberately or accidentally left out, or irrelevant parts could have been observed. This might have occurred because respondents were uneasy with the actual performance or might exaggerate the activities involved. To counter this as much as possible, the observations were conducted on the same days as the interviews. This, including some small talk before both the interviews and observations, created a more relaxed atmosphere. Moreover, during one of the observations, working along with the employees, including taking lunch and coffee breaks together, enhanced a relaxed atmosphere.

The first observations were involved with the supply process step of storing the building components. From there, linear snowball sampling techniques, which refer to a method wherein participants only refer to one other participant (or in this case: practices) at a time (Bhat, 2018), were used to trace back different practices within the other supply processes. Here, the preliminary mapped practices from the interviews were guided as a checklist to ensure that all the processes and practices were taken into account, and/or to check if some were neglected within the interviews.

There were two reasons for choosing this supply process to conduct the first observation. First, via this method, it was more likely that the sequences of practices in a row were being

observed and interlinking practices were not being overlooked.

Second, it was a hypothesis that all of the different supply processes are involved within each CBH. Hence, this research had a certain bias in terms of which supply processes the CBHs entail and which practices were to be encountered. By setting a starting point at the end and tracing backward the diverse supply processes, it was more likely that all involved supply processes were being mapped and possibly others were not overlooked or those that were not involved were being searched for.

A possible danger was when certain supply processes were accidentally overlooked, for example, because the involved practitioners accidentally forgot to perform them, this could create a bias that these supply processes were not involved at all. To counter this as much as possible, the same chart from the interviews was actively used and sometimes modified during the observations.

5.4.3 Focus group discussion

A focus group discussion (FGD) is held with relevant stakeholders concerning the supply processes of CBHs. An FGD is “a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research” (POWELL en SINGLE, 1996, p.499.). This method was used for three reasons. First, because it is a valuable method to delve deeply into a particular topic or issue (Powell & Single, 1996). Second, it helps participants to explore and clarify their views on a particular topic since it can actively facilitate the discussion, whilst also generating innovative insights (Kitzinger, 1995). Third, because a focus group enables the researcher to concentrate time and resources on the study's most important variables (Powell & Single, 1996)

The FGD aimed to develop a comprehensive understanding of the influence of the constraining and enabling factors on the core practices within the supply processes. Practitioners direct or indirect

Overview conducted observations	
Pseudonym	Location
Observation 1	Circular building hub: ADEX Groep
Observation 1	Circular building hub: 2dehandsbouwmaterialen.nl
Observation 1	Disassembling site
Observation 1	Circular building hub: BORK Groep

Tabel 5-5: Overview of the conducted observations. Including: Pseudonym, and the name of the location where the observations were held.

Overview participants Focus Group discussion		
Pseudonym	Organization	Function
Participant 1	ADEX Groep	General employee (indirectly involved in the supply processes)
Participant 2	BORK Groep	General employee (indirectly involved in the supply processes)
Participant 3	Stichting Insert	General employee (indirectly involved in the supply processes)

Tabel 5-6: Overview of the participant of the focus group discussion. Including Pseudonym, organization name, and function description.

involved in these supply processes were being targeted, which resulted in both employees from the selected CBHs and a general expert regarding reusing secondary building components, participating in the FGD (See Tabel 5-6 on page 47).

The targeted data in the FGD include opinions and facts about the influence of the constraining and enabling factors on the core practices. By focusing the discussion on such data, a more all-encompassing and comprehensive interpretation of the factors was established. To produce as much data as possible, the FGD and target data outcomes were structured around two data sets:

- ☒ The scoring table: Frequency and influence
- ☒ General discussion on the influence of the factors.

The general discussion topics during the FGD were based on the results from the scoring table: Frequency and influence (see "Appendix E - The scoring table: Frequency and influence (1/2)" on pagina 153), and topics derived from the data analysis (see Chapter 5).

The FGD was divided into three phases: 1) explaining the core practices, 2) individually but open scoring the frequency and influence of the constraining and enabling factors, and 3) open and interactive discussion regarding the scoring and general discussion topics. By structuring the FGD like this, three advantages were established. First, it was more likely that all the participants understood their contribution to the discussion. Second, a larger data set was examined and all the involved factors

were scored. Third, there was room for spontaneous discussion regarding conflicting scorings on the factors which resulted in more rich data. The third advantage was particularly important because "it is important to try to distinguish between individual opinions expressed despite the group from the actual group consensus" (Kitzinger, 1995, p. 3).

The scoring table: Frequency and influence

The scoring of the frequency and influence of the constraining and enabling factors was utilized to gain an overall understanding of the influence of each factor on the scalability of the involved core practices and to provide input for the general discussion. Although the scoring system is based on quantitative numbers, and the amount of response from a quantitative perspective is limited, combining the two has some advantages. For example, it can be used "to validate quantitative findings by referring to information extracted from the qualitative phase of the study" (Onwuegbuzie en Leech, 2005, p. 384). Also, it can be used to verify findings from the qualitative study (Onwuegbuzie & Leech, 2005). Furthermore, people may not always effectively communicate the extent to which a particular factor influences their activities. Employing a numerical rating scale to assess the influence enables individuals to convey the strength of their preferences and make subtle distinctions between factors. Finally, utilizing this method was very useful to function as input for the general discussion. Mainly due to the amount of factors that were identified. Hence, it was useful to prioritize based on the scoring. In conclusion, combining

these two methods and approaches allowed for a more comprehensive understanding of the factors involved.

The scoring of the influences from the factors was based on two indicators: 1) frequency of the factors, and 2) influence of the factors. Measuring the influence of constraining and enabling factors on the scalability of the core practices, based on both frequency and influence, is useful because it provides a more comprehensive and nuanced understanding of the impact of each factor for several reasons. First, while high-frequency factors may be common, they may not always have a significant impact on the scalability. Conversely, low-frequency factors could have a substantial influence when they do occur. Hence, examining both indicators ensures that no important factors are left out. Second, examining the two indicators helps in prioritizing more important factors effectively. High-frequency, high-influence factors can be prioritized as very important and thus higher priority. Low-frequency, high-influence factors can be considered as potential risks. High-frequency, low-influence factors may not require as much attention depending on the factor. Finally, the combination of frequency and influence allows to proactively track potential dangers when factors change. For example, factors that are infrequent today might become more common in the future due to changing market

conditions or regulations. Being aware of their potential influence allows for proactive adaptation.

In difference to the participant of the FGD, three other contributors also scored the frequency and influence of the factors (See Tabel 5-7 on page 48).

5.5 Data analysis

After the data collection phase, the results were analyzed and the social practices and the constraining and enabling factors involved in supply processes were established. The analysis of the data was guided by the conceptual framework. In total, the data analysis was divided into four phases:

1. **Preparation of the data phase**
2. **Constructing the practices phase**
3. **Analyzing constraining and enabling factors phase**
4. **Analyzing the influence of the constraining and enabling factors (on the core practices-as-entities phase)**

As described in the introduction of this chapter, to accomplish a deeper understanding of the empirical data, this research was developed via a methodological triangulation analysis. The different

Overview contributors scoring table: Frequency and influence		
Pseudonym	Organization	Function
Contributor 1	ADEX Groep	General employee (indirectly involved in the supply processes)
Contributor 2	BORK Groep	General employee (indirectly involved in the supply processes)
Contributor 3	Stichting Insert	General employee.
Contributor 4	2dehandsbouwmaterialen.nl	Overseer of operational supply processes (directly involved in the supply processes)
Contributor 5	BORK Groep	General employee (indirectly involved in the supply processes)
Contributor 6	Hoogeboom	General employee (indirectly involved in the supply processes)

Tabel 5-7: Overview of the contributors to the scoring table: Frequency and influence interviews. Including Pseudonym, organization name, and function description.

data sets, derived from different methods and data sources, have been used to analyze which social practices and constraining and enabling factors are involved in the supply processes and to what extent the latter two influence the former. Collecting data from four separate case studies enabled this research to use triangulation when the comparing and cross-verifying of the findings from different supply processes was conducted. Moreover, this allowed for rendering diverse observed practice-as-performances and translating them as core practices-as-entities that are more generalized.

5.5.1 Data Analysis Phase 1: Preparation of the data

In the first phase, the collected data was prepared by transcribing all the interview recordings and working out all the field notes and photographs taken during the observations.

For this research, verbatim transcription was chosen as the primary method for transcribing the collected data. Verbatim transcription involves capturing everything that is said by the interviewee while disregarding pauses, the wording used frequently as stop words, and stuttering (Smits, 2019).

This method was selected because it aligns with the research objectives, which aim to investigate the practices within the supply processes of CBHs. This method enabled a thorough analysis of the opinions and facts provided by the interviewees. By capturing the actual words spoken, verbatim transcription allowed for an in-depth examination of the activities involved in the practices, the skills, and knowledge required to execute them, as well as the meanings and motivations associated with these practices. Although this method may result in the loss of information about how someone says something, it allows for a detailed examination of opinions, facts, and the expression of meaning.

However, to counter this loss as much as possible, brackets [] have been utilized to indicate instances where text was either inaudible or unclear

or where certain expressions of meanings were made. Hence, brackets have been employed to include additional information or interpretations of the intended meaning when the spoken words alone are insufficient to convey the full context or intention of the interviewee's statements (thus, these expressions are interpreted by the author).

Verbatim transcription, with the use of brackets to address unclear or missing information, allowed for a detailed examination of both explicit and implicit content, providing a deeper understanding of the practices and their elements.

Actions performed for the transcriptions preparation

The following programs¹ and actions have been utilized/performed for preparing the transcripts:

Action 1: Preparing the transcriptions (In Adobe Premiere Pro, Amber Script, Happy Scribe, Microsoft Word):

1. Using software to automatically transcribe the audio files (Adobe Premiere Pro 2023, Amber Script, and Happy Scribe).
2. Go over the text and improve, remove, and add sentences and grammar control (Adobe Premiere Pro, Amber Script, and Happy Scribe).
3. Add and separate automatic transcribe text from different speakers (Adobe Premiere Pro 2023, Amber Script, and Happy Scribe).
4. Remove excess transcribed data of separation process from speakers (Microsoft Word)
5. Final text content check and final grammar check (Microsoft Word).

Action 2: Preparing the analyses (In ATLAS.TI version 23.2.2.27458):

1. Read through the text.
2. Create text-based coding on text content (see coding in). The coding was based on the

¹ Adobe Premiere Pro, Amber Script (<https://www.amberscript.com/en/>), Happy Scribe (<https://www.happyscribe.com/>), Microsoft Word and ATLAS.TI (<https://atlasti.com/>).

Example coding
Constraining factors
Enabling factors
External process Extern - Competences
External process Extern - Material
External process Extern - Meanings
External process Extern - Practice
Process: Collecting - Competences
Process: Collecting - Material
Process: Collecting - Meanings
Process: Collecting - Practice

Tabel 5-8: *Examples of the coding that was applied to the text content from the transcribed interview data.*

research questions and the conceptual framework. As such coding was generated for constraining and enabling factors, for each supply process (for example "Process: Collecting"), and a general coding for external processes. Within each of these processes, a distinction was made based on SPT, resulting in coding for whole practices as well as for each element (Competences, Meanings, and Materials) (See Tabel 5-8 on page 50 for some example coding).

1. Re-read all coding and when necessary re-code.
2. Create naming for practices and link or merge different codes that encompass the same practices.

Action 3: Preparing field notes and photographs taken during the observations (In Microsoft Word).

1. Re-writing the field notes in Microsoft Word.
2. Adjust and enrich description data using photographs.

5.5.2 Data analysis phase 2: Constructing practices

In the second phase, data derived from the interviews and observations was utilized to construct the different (core) practices. The

practices were constructed through five steps.

Step 1: Constructing practices-as-performances from the interview data sets

In the first step, social practices-as-performances were constructed from the interview data sets. For the construction of these practices-as-performances, the preparation data from phase 1 in ATLAS.TI was utilized and the construction was guided by the conceptual framework. These practices were constructed separately for each case study.

To illustrate the process: First, all the data that was coded as 'Process: Collecting – Practice' was carefully examined. Second, linkages were made between different data points describing different (parts of) bodily activities of one practice within his coding. This was guided by the 'conceptual rules for bodily activities' from the conceptual framework. This was done for all the data within this coding and resulted in one or more practices per (external) supply process. Next, from the other coding that described elements from practices within the collecting process (for this example the coding: 'Process: Collecting – Competences', 'Process: Collecting – Material', and 'Process: Collecting – Meanings'), linkages between the elements of competences, meanings, materials, and the corresponding practices were made. As a result, four overviews of the supply processes in which diverse practices-as-performances were constructed.

Step 2: Complementation analysis between the interview and observation data sets

In the second step, complementation analysis was used to gain a more comprehensive understanding of the social practices-as-performances involved in each of the four case studies. Therefore, the complementary analysis was applied similarly but separately in the data sets of the four different case studies.

This analysis was conducted because, during the data-collecting phase, certain aspects or elements of the practices were (potentially) missed due to the data-collection methods. To elaborate, the main objective of both data collection methods (interviews and observations) is to understand the

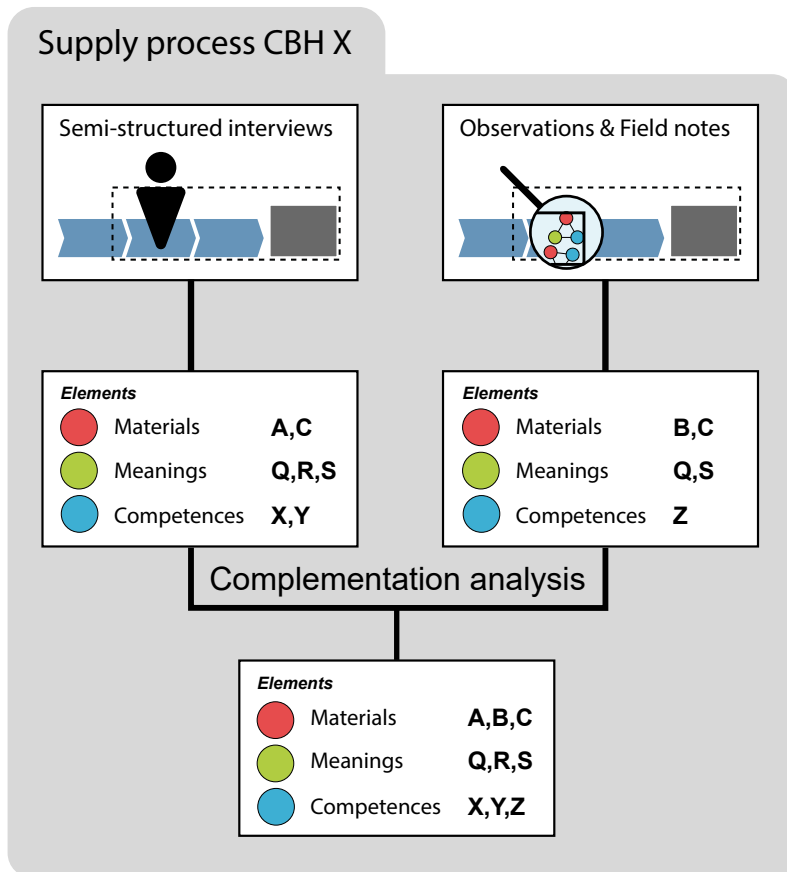


Figure 5-2: Illustration of how the complementation analysis is conducted for each case study separately.

social practices involved in the supply processes. However, the data collection methods were chosen due to their diverse characteristics in collecting the data and the enrichment they can provide while complementing each other's findings. As such, interviews had a greater focus on the meanings and competences of the practices. The observations and field notes further enriched this data by having a greater focus on the materials and contexts involved.

Complementation analysis refers to the analysis of the data sets derived from the two different data collecting methods (interviews and observations) and then complementing each other's findings in terms of the involved elements in each practice observed. To illustrate the approach: when possible, data from the field notes and photographs was added to the corresponding coding of the interviews (Figure 5-2 on page 51). For example, it was observed that certain material elements were

utilized to perform a practice, but these elements were not mentioned during the interviews.

Step 3: Defining the practices-as-entities in the synthesis phase

In step three, the synthesis phase, the outcomes from steps one and two were combined. First, the practices-as-performances within the four overviews of the supply processes were cross-verified to identify common themes and patterns. Second, the practices-as-performances were combined when the coding describing the practices, and the involved elements could be confirmed and cross-validated with the findings of other data sets (supply processes). As a result, the practices-as-entities were defined.

To illustrate the process: In case study A, the practices of disassembling were described via three different bodily activities, five material elements, four competences elements, and two meanings elements. In case studies B

and C, the description of the practices were almost identical, but included two extra bodily activities. Moreover, two extra elements (e.g. one meaning and one competence) were found. Since these two practices-as-performances were almost identical, all the bodily activities and elements were combined as described as the practice-as-entity of disassembling. Finally, the practices-as-entities were fully written out in Microsoft Word (See "Appendix C – Tables of the practices" op pagina 130).

Step 4: Cross-verifying missing practices and elements

In the fourth step, the practices-as-entities from the third step were used to construct possible missing practices-as-entities. There were two reasons for applying this method. First, to gain a more comprehensive understanding of the mechanisms of the supply processes. Second, there was a possibility that important practices were missed

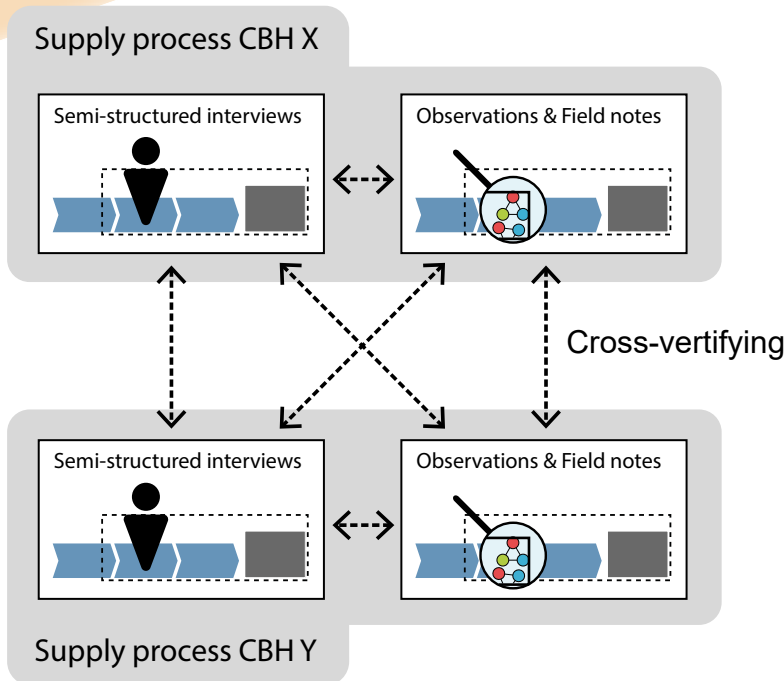


Figure 5-3: Illustration of how the cross-verification analysis that is conducted between the data sets from each case study.

during the construction of the practices-as-performances.

To construct these new hypothetical practices, at least three individual data points had to indicate that such a practice was present (Figure 5-4 on page 52). These data points could be derived from the data from the interviews observations or insights gained from the overview of the practices-as-entities: from the third phase (Figure 5-3 on

page 52).

To illustrate the process: From the first three steps, no practice was constructed that indicated that secondary building components were visually inspected before practices in the ‘Repairing, refurbishing, and remanufacturing’ processes. However, all four case studies did perform certain practices within the ‘Repairing, refurbishing and remanufacturing’ supply process. To perform practices here, the competence element of ‘Knowing which building components to repair/refurbish/remanufacture’ has to be involved. Such competence elements could only derive from first inspecting the secondary building components. Hence, the practice of ‘Inspecting building components’ had to be conducted before the practices within the ‘Repairing, refurbishing, and remanufacturing’ supply process.

Step 5: Defining the core practices-as-entities

In the fifth step, the core practices-as-entities (core practices) were defined. The core practices were defined when they and the elements from which they were constructed, could be confirmed and cross-validated with the findings of at least two separated data sets (supply processes) from step 3. Or when multiple data sets from at least two different case studies in step 4 indicated that they

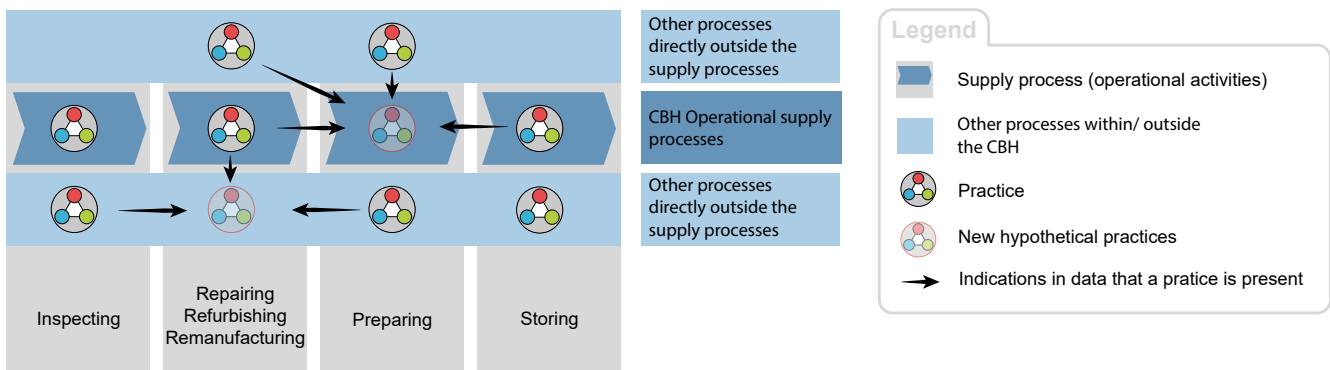


Figure 5-4: Illustrative overview of how different locations of data points can be utilized to cross-verify missing practices and elements throughout the supply process.

were present.

Data analysis phase 3: Analyzing constraining and enabling factors

In the third phase, the constraining and enabling factors were analyzed. The constraining and enabling factors were extracted from the interview data and the data analysis via three steps.

Step 1: Defining constraining and enabling factors from the interview data

In the first step, constraining and enabling factors have been analyzed utilizing the prepared data from phase 1. These factors were specifically mentioned by the interviewees. First, this was conducted separately in the data from the four case studies. Hereafter, utilizing ATLAS.TI, the factors were compared and cross-verified, and when applicable the factors were combined. As such, a richer understanding of each factor was understood.

Step 2: Defining enabling factors from the data analysis

In the second step, extra enabling factors were extracted by analyzing the case studies and the core practices. To extract the factors from the case studies, a comparative analysis between the case studies was conducted. Here, analyzing both their commonalities and differences, potential enabling actors were subtracted. To extract enabling factors from the core practices, an in-depth analysis of these practices, including connections between them, their shared elements, and practice bundles was analyzed.

Step 3: Enriching the constraining and enabling factors

In the third and final step, the description of the discovered constraining and enabling factors was further enriched by the data derived from the comparative analysis between the case studies and the in-depth analysis of the core practices.

5.5.3 Data analysis phase 4: Analyzing the influence of the factors

Finally, in the fourth phase, the influence of the constraining and enabling factors on the scalability of core practices was analyzed. This analysis

was based on two data sets derived from the Focus Group session: 1) the data set regarding the scoring on the frequency and influence of the factors, and 2) the analysis of the in-depth discussion of these results. As such, the first data set was utilized to gain an overall understanding of the influence of the constraining and enabling factors, and the second data set was utilized to gain a more comprehensive understanding of this influence, including different complex nuances and contextual conditions.

5.6 Ethics

The methods of data collection chosen for this research required primary data of daily work-related activities that participants from the interviews, observations and focus group discussion performed. This information could be sensitive to share. As such a data management plan (DMP), describing how the data is generated or used within a given project, was designed to reduce the risk of data loss, data breach, or other threats that could render the data illegible or unusable. Moreover, approval for Human Research was provided by the Delft University of Technology Human Research Ethics Committee (HREC Approval 1, n.d.) (See "Appendix G - Ethical clearance Committee TUD" op pagina 159).

All active participants of the interviews, observations, and focus group discussion were informed about the research and data collection process before the data collection. They all signed a consent form (approved by the Human Research Ethics Committee) allowing the data to be used for research purposes (See "Appendix F - Blank consent form (1/4)" op pagina 155).

5.7 Validity of the research

The theoretical framework has been developed and grounded on social practice theory literature research, to provide a comprehensive understanding of the various practices conducted at the CBHs, thereby reinforcing its internal validity. Internal validity refers to *"the degree to which a researcher is justified in concluding that an observed relationship is causal"* (Johnson, 2019, p.

6). Based on the theoretical framework, the conceptual framework has been developed to enhance applicability on the subject of CBHs and contextual boundaries. It further outlined the supply processes of CBHs based on the preliminary literature study strengthening its internal validity. Additionally, for the conducted case studies, internal validity has been enhanced by establishing predefined selection criteria that the chosen cases had to meet. However, the generalizability of the findings to broader contexts or comparable examples can be difficult, specifically when the study encompasses only a limited number of cases. As such, the study tried to overcome these difficulties by examining several cases.

In the case of semi-structured interviews, internal validity has been further enhanced through the creation of a structured interview protocol beforehand (Baxter & Eyles, 1997), based on the pre-established supply processes, and the selection of interviewees based on their involvement and expertise with CBHs. Observations were conducted after the interviews with interviewees representing one of the case studies, to further enhance the validity of the findings. To ensure the internal validity of the primary data, all interviews were carefully recorded, transcribed, and subsequently cross-validated by each respective interviewee.

are identified from interviews and through comparative analysis. Fourth, the influence of these factors on the scalability of core practices is analyzed using data from the Focus Group session, including frequency and influence scoring and in-depth discussions.

5.8 Concluding chapter 5

In conclusion, this chapter explains the research methodology and data analysis process. The research adopts a qualitative case study exploratory research approach. Qualitative research within a case study is chosen for its suitability in exploring complex social phenomena within specific contexts. Case study selection criteria are outlined to ensure compatibility and data enrichment, after which four case studies are introduced. The primary data collection methods encompass semi-structured interviews, observations, and a focus group discussion. The data analysis process develops through four phases. First, data is prepared by transcribing interviews and organizing field notes. Second, social practices are constructed from interview and observation data. Third, constraining and enabling factors

6. RESULTS

6.1 Introduction

This chapter outlines the results of the research. First, the results from the case studies are presented. For each case study, a description is provided regarding the overall mechanisms and characteristics of the business model of the CBHs, including locations, material streams, targeting buyers, employment strategies, and integrated digital systems. Also, based on the observed practices-as-entities in "Appendix C – Tables of the practices" op pagina 130., an overview of secondary building component supply processes (supply processes), for each case study is outlined. A short description is provided based on deviations from the hypothesized supply processes from the introduction.

Second, based on the results from the four case studies, a comparative analysis between the case studies is outlined. Analyzing the results regarding the general mechanisms and characteristics of the four case studies, a few interesting observations were made. Both commonalities as well as differences between the overall mechanisms and strategies are elaborated on. Here, the overall supply process which is generally involved in the concept of a CBHs is illustrated. This overview and description of the supply processes are different compared to the initial hypothesis regarding the arrangement and number of different supply processes, as established in the introduction of this research.

Third, based on the observed practices and the overall supply process, the core practices-as-entities embedded within the different supply processes are outlined. These core practices-as-entities are divided into two groups: 1) embedded within the operational supply processes, and 2) embedded directly outside the supply processes. The core practices-as-entities are constructed following the conceptual framework.

Fourth, based on the outcomes of the core practices-as-entities, an in-depth analysis of these

core-practices-as-entities provides a few interesting observations.

Fifth, the constraining and enabling factors are described. These factors are derived from the interviews, the comparative analysis between the case studies, and the in-depth analysis of these core-practices-as-entities.

Finally, the influence of the constraining and enabling factors on the core practices-as-entities is elaborated on. These results are based on the focus group discussion.

6.2 Results from the case studies

In this paragraph, the four case studies are described, outlining the overall mechanisms and characteristics of each CBH. This description is structured around three main topics: First, following a general order, the company name and name of the CBH, motivation for the creation of the CBH, location, and purpose of the CBH, strategic choices regarding the processing of secondary building components and description of processes at the CBH, the components origin, a description of their disassembling team(s), marketplace activities and other utilized software are described. Second, a description and overview of the supply process for each CBH are provided. Finally, a few practices within the supply processes of each CBH are generally touched upon. A more detailed description of these practices can be found in "Appendix C – Tables of the practices" op pagina 130.

6.2.1 Case 1: ADEX Groep (Utrecht)

With the circular building hub (CBH) of ADEX Groep, officially named the ADEX Hubs, the company created its entrance into the circular economy by "high-quality reuse of materials released from dismantling" (adex.nl, n.d.), which made the profitability from reusing secondary building components at an earlier stage in the projects easier (Interview 7). However, interestingly, from the interviewees, it became clear that they do not make much money from the CBH activities, but it's mainly to iron out the teething problems, to prepare and innovate for future business activities

(Interview 1).

Strategically situated in Utrecht (central in the Netherlands), the location of the hub serves multiple purposes. First, it provides a spacious area that accommodates the growing demands, since a modest storage area is required for the concept of a CBH (Interview 7). Second, its proximity to projects, which mainly occur in the more concentrated Randstad urban area in the Netherlands, enhances operational efficiency. (Interview 7). Third, its location near urban centers allows ADEX Group to contribute to the development of young individuals facing employment challenges which they see as an important opportunity within the circular economy transition (adex.nl, n.d.-a). Therefore, to provide youth with assistance, they have their own SROI-Coach working full-time at the Hub (Interview 1).

ADEX Group has creatively devised three streams for secondary building components and materials: 1) low-grade recycling, 2) high-grade direct reuse, and 3) moderately graded building components that require (minimal) processing (Interview 7). They prioritize reuse over recycling but are open to recycling if necessary (Interview 1). The first group, low-grade recycling, is not processed in their CBH, but elsewhere. The high-grade direct reuse group involves repurposing secondary building components before the components are even disassembled, eliminating the need for a hub. Remarkably, this approach succeeds in roughly 70% of projects (Interview 7). However, in the remaining 30%, the CBH steps in. Here, the third group (moderately graded building components), requires some preparatory work such as removing nails, sawing, packaging, and sorting before they are suitable for reuse. Moreover, ADEX Groep is capable of certifying secondary timber components. Hence, the purpose of the hub is first to create a central place for the storage and transshipment of secondary building components, and also for bridging the gap in time for finding a new purpose (Interview 1). Second, to perform some preparatory work. Besides timber, most secondary building components are not processed or tested, however, since they assume that when they remove, for example, technical installations from a building,

they are in working condition (Interview 1). Hence, they don't inspect everything separately (Interview 1). As such, ADEX Groep aims to stick to its core business of demolition, dismantling, and selling raw building components to buyers. As a result, they actively seek collaborations with other companies to conduct more specialized preparatory work for making secondary building components reusable (Interview 1). For example, they have specific buyers who purchase hardwood for remanufacturing purposes (Interview 2).

Another reason why they intentionally deliver raw building components and do not aim to provide highly refined products is that it would be too expensive (Interview 2). Nonetheless, in their fully-equipped woodworking shop, damaged or unusable timber derived from their projects is processed into new wooden building components. Here, five standard products emerge from these damaged secondary building components (Interview 7). Moreover, creative minds explore ways to repurpose even the remnants into new secondary building components (Interview 7).

The CBH of ADEX Groep focuses solely on the building components of their projects (Interview 7). The reason for this is rooted in their attention to quality. Specialized dismantling teams ensure that the input from their projects meets higher standards: "We don't do that because we think it's a cool story, but we do that because the quality of those materials just has to be good and if you have a demolition team doing it, then that's just not the case" (Interview 7). They select and or train their specialized dismantling teams because these employees find it more enjoyable to work on dismantling projects (Interview 7). They also involve these colleagues actively in the entire process of what happens with secondary building components and actively encourage a patient and controlled approach to the work (Interview 1). Moreover, ADEX Groep specifically and strategically trains their employees first at the CBH, giving their employees a better understanding of what to do during other processes such as dismantling (Interview 1).

As such, they also have employees permanently stationed at the hub to organize everything in terms of planning, receiving customers, setting up, etc.

Finally, ADEX Groep sees that relying on demolition teams from third parties, this task often results in lower-quality building components, inviting unwanted issues (Interview 7).

ADEX Group sells its secondary building components via a marketplace, which they do in collaboration with Stichting Insert¹ (Insert.nl, n.d.) . Next to the Insert marketplace, they also utilize Marktplaats.nl (Marktplaats B.V., n.d.) to sell their secondary building components. Moreover, occasionally they receive potential consumer buyers at the location of the CBH, mainly because it generates more revenue (Interview 2), although their main focus is on business-to-business sales via the marketplaces or other means such as directly calling potential buyers (Interview 1). To stimulate this, they actively keep track of what their customers want and what they have purchased, so they can reach out to them later revenue (Interview 2). Finally, ADEX Groep actively focuses on not becoming a hub full of many diverse building components (e.g. such as a hardware store)

(Interview 1). This, among other things, is also why high-tech items in buildings (e.g. sensors, air conditioning, central heating units, etc.) are often not of interest to them (Interview 2). Moreover, they aim to sell everything as early as possible in the process (Interview 1). Consequently, they often conduct visual inspections between the collecting and transportation processes, proactively list the potential inventory on the marketplace or present them to potential buyers before the collecting process. This proactive approach minimizes the need to store excess products at the hub.

Next to the marketplace activities, ADEX Group embraces digitization with among others digital tools including a proprietary materials inventory app, and software for creating material passports and measuring CO² impact (adex.nl, n.d.-b). Their inventory app allows them to calculate costs afterward and visualize their CO² savings. They emphasize CO² savings as a way to distinguish themselves from similar companies (Interview 1).

¹ The Insert Foundation describes itself as an innovative, “circular platform” (Insert.nl, n.d.). Together with their partners, their goal is to support transition from a linear to a circular economy in the construction, green and civil sector (Insert.nl, n.d.). Specifically, Insert Marktplaats is a platform where companies can offer their used materials from construction and outdoor space and green objects. With more than 30 providers, 250 project locations and thousands of reusable secondary building components, Insert Marktplaats has grown into the largest circular platform in the Netherlands for the construction, civil and green sector (Insert.nl, n.d.).

Operational secondary building component supply processes from the ADEX Groep Circular building hub

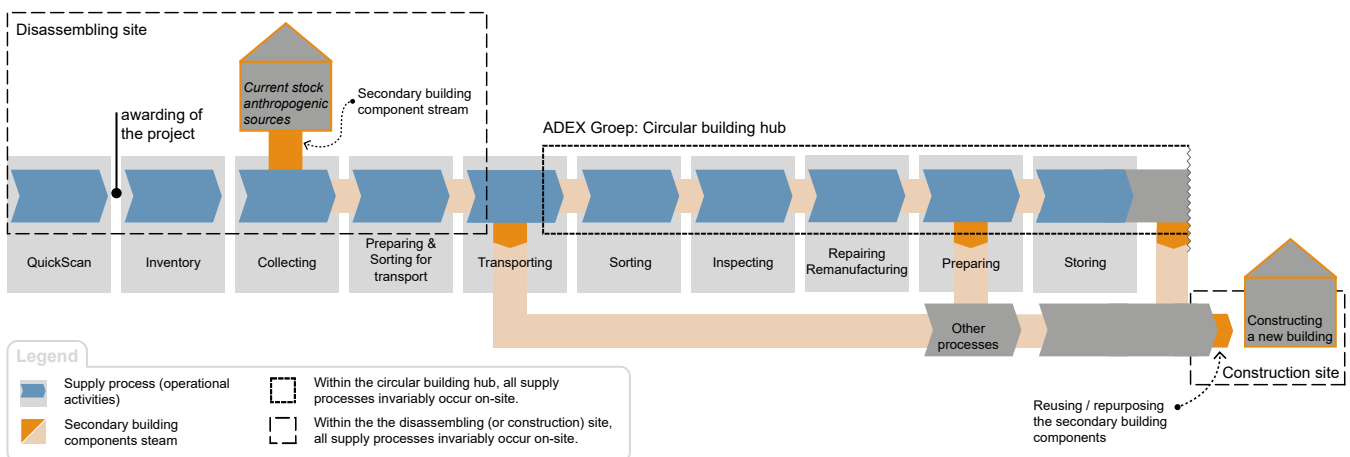


Figure 6-1: Illustrative overview of all the secondary building component supply processes based on the results of the case study analysis of ADEX Groep.

Supply processes of the ADEX Groep CBH

In contrast to the initial hypothesis regarding the arrangement and number of different supply processes, as established in the introduction of this research, the supply process of ADEX Groep involves two extra processes: the 'Quickscan' and 'Preparing & Sorting for transportation' processes (See Figure 6-1 on page 57).

ADEX Groep involves the Quickscan supply process in most cases before the project is awarded. As such the main outcome of the supply process is a general idea about the potential secondary building components within the building structures. The main drive for performing the supply process is being able to calculate a profitable margin from the project while also winning the tender to get the project awarded (Interview 1). Moreover, this process also allows them to actively search for secondary building components which they offer to their potential buyers even before the demolition and collection processes begin (Interview 1)

The Preparing & Sorting for transport supply process is in most cases conducted because secondary building components are often being sold directly from the disassembling site (Interview 1). As such, they often require some additional preparation that otherwise would have been conducted at the CBH. ADEX Groep specifically has some innovative tools that they utilize to make transportation more efficient such as a compressing machine for compressing insulation materials.

Practices within the supply processes of the ADEX Groep CBH

"Appendix C – Tables of the practices" op pagina 130 provides a bundled overview (including bundled elements from all practices observed in all the case studies) of all practices that ADEX Groep performs throughout the supply processes.

6.2.2 Case 2: BORK Groep (Hoogeveen)

With the circular building hub (CBH) of BORK, officially named 'circulaire HUB', the company launched a place with a logistical function for circular building components: "With the construction of the circular HUB, BORK is shaping the circular mission and vision it pursues" (Borkgroep.

nl, n.d.). However, interestingly, from the interview, it became clear that they do not make much money from the CBH activities, but it's mainly to iron out the teething problems, to prepare and innovate for future business activities (Interview 5).

Situated in Stadterij - Hoogeveen (north-east in the Netherlands), the circular building hub (CBH) of BORK serves multiple purposes. First and foremost, the purpose of the hub is to create a spacious central place for the storage and transshipment of secondary building components, and also for bridging the gap in time for finding a new purpose (Interview 5). Second, in the hub, the performance of some preparatory work can be conducted to make secondary building components suitable for reuse (Interview 5). Third, it provides a spacious area that accommodates the storage demands required for the concept of a CBH. Finally, due to the location in Hoogeveen, BORK Groep specifically focuses their range area in the north-east part of the Netherlands to minimize transport costs (Interview 5).

According to BORK, the distinction between the reuse of building components and the recycling of construction materials is important (Borkgroep.nl, n.d.). As such, BORK roughly divides three streams for secondary building components and materials: 1) recycling materials, 2) building components that require (minimal) processing, and 3) direct reuse of secondary building components. They prioritize reuse over recycling but are open to recycling if necessary (Interview 5).

The first group, recycling, is not processed in their CBH, but elsewhere both in the Netherlands and Germany (Interview 5). The third group 'direct reuse of secondary building components' involves repurposing secondary building components directly from the disassembling site, eliminating the need for a hub. This approach succeeds in most of the components coming from their project sites (Interview 5). For the remaining components, the CBH assumes a critical role in terms of bridging the gap in time for finding a new purpose. The third group 'building components that require (minimal) processing' require some preparatory work such as removing nails, packaging, and sorting, which are conducted at their CBH, before they are suitable for reuse (Bork, 2021). Besides timber, most secondary

building components are not processed, tested, or even inspected at the hub (Interview 5). The reason for this is that they assume that when they remove, for example, technical installations from a building, they are in operating conditions (Interview 5). As such, BORK Groep aims to stick to its core business of demolition, dismantling, and selling raw building components to buyers. As a result, they actively seek collaborations with other companies to conduct more specialized preparatory work (e.g. refurbishing or sawing) for making secondary building components reusable. For example, they have in collaboration with the Stichting Insert foundation specific customers who purchase hardwood and remanufacture such components, and many other partners who recycle certain material types ("Insert - Hardhout," n.d.; Interview 5.). This allows them to collect different secondary building components and directly sell them to these partners (Interview 5). To provide an example, although it was mentioned by multiple interviewees that disassembling kitchens is often labor-intensive work which is usually unprofitable, the partnership of BORK Groep results in that they often disassemble such components since they can sell them directly to one of these partners (Interview 5).

The CBH of BORK Groep solely focuses on the building components of their projects (Interview 5). Moreover, specialized disassembling teams ensure that the input from their projects meets higher standards, although these teams are not yet fully employed with such work (Interview 5). They select their specialized dismantling teams, because these employees find it more enjoyable to work on dismantling projects (Interview 5). They also involve these colleagues actively in the entire process of what happens with secondary building components and actively encourage a patient and controlled approach to the work (Interview 5). They do not have an employee permanently stationed at the hub to organize everything such as planning, receiving customers, and setting up processes, since their revenue is not yet large enough to pay for such activities (Interview 5). However, BORK Groep does have another company/a social workshop that occasionally repairs and cuts wood for them (remanufacturing). After these processes, they also take back the secondary building components to resell

(Interview 5).

Bork Groep sells its secondary building components through a collaborative marketplace effort with the Stichting Insert Foundation (BTTR, n.d.). Next to the Insert marketplace, they also utilize Marktplaats.nl (Marktplaats B.V., n.d.) to sell their secondary building components. Moreover, exceptionally they receive potential consumer buyers at the location of the CBH, although their main focus is on business-to-business (B2B) sales via the marketplaces or other means such as directly calling potential buyers (Interview 5). The reason for this, according to the interviewee, is that it is easier, takes less time and B2B often results in selling larger quantities at once (Interview 5). As a result, they usually don't inspect, unless it revolves around timber which needs minor repairing (removing nails), and sort secondary building components on the hub, but directly unpack it from a transportation device onto the storage location (Interview 5). They only sort secondary building components after they are sold and when they receive a specific request for a certain number of beams of certain sizes from their buyers (Interview 5). Finally, because they focus on B2B, they don't specifically photograph every object at the hub unless they are very special items (Interview 5). Due to these choices, BORK Groep consciously uses certain "bokken" (smaller transport racks) that make both transport and storing, and possibly inspecting, easy, without the need for additional handling. Hence, BORK Groep actively focuses on not becoming a hub full of many diverse building components (e.g. such as a hardware store) (Interview 5). This, among other things, is also why high-tech items in buildings (e.g. sensors, air conditioning, central heating units, etc.) are often not of interest to them (Interview 5). Hence, they mainly focus on raw building components and occasionally on interior furnishings such as tables, desks, etc. (Interview 5). Moreover, they aim to sell everything as early as possible in the process. Consequently, they often conduct visual inspections between the collecting and transportation processes, proactively list the potential inventory on the marketplace and present them to potential buyers before the collecting process (Interview 5). This proactive approach minimizes the need to store excess products at the hub.

In addition to these digital marketplace activities, BORK utilized other digital tools, including a proprietary materials inventory app (Interview 5).

Supply processes of the BORK Groep CBH

In contrast to the initial hypothesis regarding the arrangement and number of different supply processes, as established in the introduction of this research, the supply process of BORK Groep involves two extra processes: the 'Quickscan' and 'Sorting for transport' processes and neglected the 'Inspecting' process (See Figure 6-2 on page 60)

BORK Groep involves the Quickscan supply process in most cases before the project is awarded (Interview 5). As such the main outcome of the supply process is a general idea about the potential secondary building components within the building structures. The main drive for performing the supply process is being able to calculate a profitable margin from the project while also winning the tender to get the project awarded (Interview 5). Moreover, this process also allows them to actively search for secondary building components which they offer to their potential buyers even before the demolition and collection processes begin (Interview 5).

The Sorting for transport supply process is in most cases conducted because secondary building

components are often being sold directly from the disassembling site. As such, they often require some additional preparation (Interview 5).

The Sorting process (at the CBH) is ignored because of their methods for transport, which is mainly due to their focus on B2B sales. As such, they skip this process and just leave larger quantities of secondary building components onto smaller transport racks without actively sorting them (Interview 5). Although they do have dedicated places for secondary building components at the CBH, both in- and outdoors, this separating directly from the transportation devices is intergraded with the Storing process.

Practices within the supply processes of the BORK Groep CBH

See "Appendix C – Tables of the practices" op pagina 130 provides a bundled overview (including bundled elements from all practices observed in all the case studies) of all practices that BORK Groep performs throughout the supply processes.

6.2.3 Case 3: 2dehandbouwmaterialen.nl (Oosterhout)

With the circular building hub (CBH) of De Heezen Bedrijven, officially called 2dehandsbouw-

Operational secondary building component supply processes from the BORK Groep Circular building hub

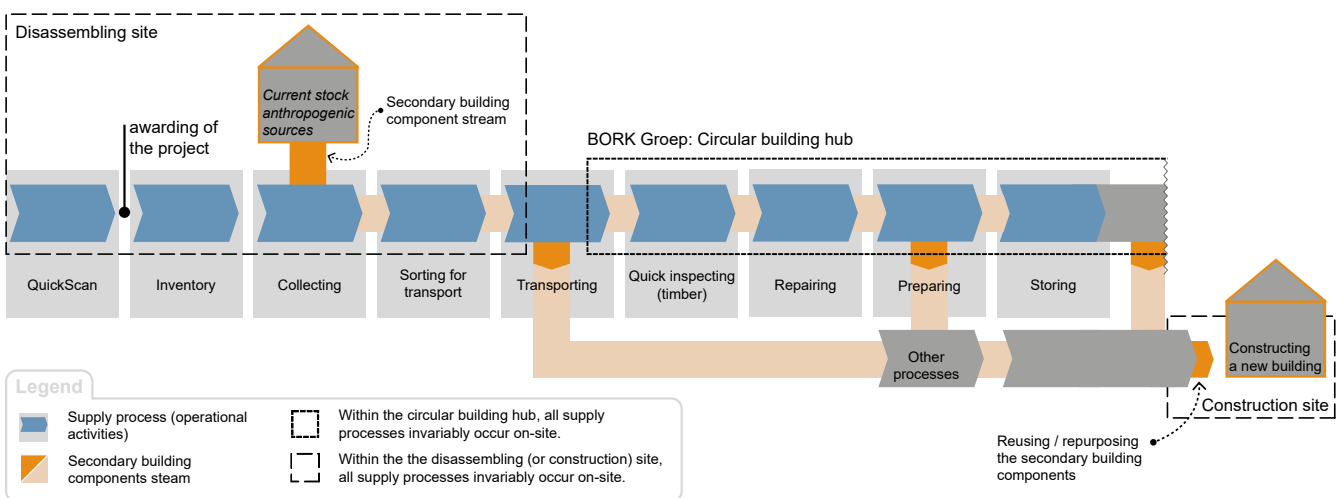


Figure 6-2: Illustrative overview of all the secondary building component supply processes based on the results of the case study analysis of BORK Groep.

materialen.nl, the company created a place where they give secondary building components a second life (2dehandsbouwmaterialen, n.d.). Interestingly, De Heezen Bedrijven, a Dutch family-owned business, operates with over 10 subsidiary companies (M.Heezen, n.d.). As a result, de CBH 2dehandsbouwmaterialen.nl receives their secondary building components from multiple companies, though mainly from M. Heezen or Vissers (two of the subsidiary companies (Interview 3). Moreover, it is noteworthy that often their demolition and dismantling teams are the same employees from one of the subsidiary companies. This results in the CBH frequently observing differences in quality and quantity in the components that arrive at the hub (Interview 3).

Situated in Oosterhout (south-central in the Netherlands), the CBH serves multiple purposes. First and foremost, the purpose of the hub is to create a spacious central place for the storage and transshipment of secondary building components (Interview 3). Second, in the CBH, the performance of some preparatory work such as removing nails, packaging, and sorting, is conducted before they are suitable for reuse (Interview 3). The location of the CBH is within the same location of the Vissers waste drop-off station. As such, the CBH has the opportunity to make use of the recycling facilities of Vissers (Interview 3). However, they prioritize reuse over recycling but are open to recycling if necessary (Interview 3). Additionally, in their fully-equipped woodworking shop, damaged or unusable timber derived from their projects is processed into new wooden building components (2dehandsbouwmaterialen, n.d.). Usually, they saw these components in standardized sizes. In some cases, they also refurbish secondary building components: "Yes, for the Gamma we do... Officially we cannot plane the timber, but of course, you can set the saw to one millimetre and then you'll just have the most damaged side of the timber beam finished, so then the beam looks very tight. The Gamma has asked for that" (Interview 3). Moreover, they endeavor to perform minor cleaning practices such as cleaning /refurbishing toilet seats (Interview 3). Besides timber and toilet seats, most secondary building components are not processed or tested, however, since they assume that when they remove,

for example, technical installations from a building, they are in operating conditions (Interview 3). Also, this would make the components too expensive due to the labor costs (Interview 3). Finally, they actively seek collaborations with other companies to conduct more specialized preparatory work for making secondary building components reusable. For example, they have specific buyers who purchase hardwood for remanufacturing purposes (Interview 3).

The CBH's primary focus lies in utilizing the building components from M. Heezen's or Vissers's projects, accounting for approximately 80-90% of their inventory (Interview 3). However, they do collaborate with select external suppliers (Interview 3). Moreover, 2dehandsbouwmaterialen.nl contributes to the development of individuals facing employment challenges which they see as an important task: "We offer them a place to work so that they can continue to be part of society. We are pleased with their efforts in the field of collecting and possibly processing the suitable materials, preparing the materials released for sale, and keeping our sales area neat and orderly" (2dehandsbouwmaterialen, n.d.). As such they sometimes employ their employees at a disassembling site. However, many of their employees from the hub, who have the right motivation to reuse secondary building components, do not always possess the necessary certifications to work at these disassembling sites (Interview 3). They are allowed at some sites, but there they can only perform simpler tasks, such as removing carpet tiles or unscrewing lamps (Interview 3). Consequently, they often rely on the demolition teams from M. Heezen or Vissers to dismantle the components. However, these employees are not always motivated to handle the secondary building components with care. As a result, their practices of motivating these employees are particularly important (Interview 3).

Beyond their social endeavors, the sale of secondary building components by 2dehandsbouwmaterialen.nl is conducted through their private online marketplace. Notably, M. Heezen is a co-founder and an active participant in the Stichting Insert Foundation (M.Heezen, n.d.). However, during the course of this research, they

have opted not to utilize the marketplace activities facilitated by the foundation. This might be because 2dehandsbouwmaterialen is still mainly focused on private consumer buyers (Interview 3). In addition to their internal platform, 2dehandsbouwmaterialen.nl also utilizes Marktplaats.nl (Marktplaats B.V., n.d.) to sell their secondary building components. While individual buyers, often homeowners, frequently visit the CBH location, the company is trying to shift away from the business-to-consumer sector through online marketplaces (Interview 3).

In addition to these digital marketplace activities, 2dehandsbouwmaterialen utilized other digital tools, including a proprietary materials inventory app (Interview 3). Also, they utilize certain registration numbers to keep track of their secondary building components: "After a quality check, everything is clearly arranged and provided with a registration number. This allows us to tell you exactly where each material comes from and the quality of the product." (2dehandsbouwmaterialen, n.d.).

Supply processes of the 2dehandsbouwmaterialen.nl CBH

In contrast to the initial hypothesis regarding the arrangement and number of different supply processes, as established in the introduction of this research, the supply process of 2dehandsbouwmaterialen.nl involves two extra processes: the 'Quickscan' and 'Preparing & Sorting for transportation' processes (See Figure 6-3 on page 62).

2dehandsbouwmaterialen.nl involves two extra processes: the 'Quickscan' and 'Preparing & Sorting for transportation' processes (See Figure 6-3 on page 62).

2dehandsbouwmaterialen.nl involves the Quickscan supply process in most cases before the project is awarded (Interview 3). As such the main outcome of the supply process is a general idea about the potential secondary building components within the building structures. The main drive for performing the supply process is being able to calculate a profitable margin from the project while also winning the tender to get the project awarded (Interview 3). The practices within the Quickscan are often conducted by calculators from M. Hezen of Vissers (Interview 3). As a result, although they have a lot of understanding of which building components are reusable, they do not always possess the right knowledge regarding what practices are needed to make those components reusable (Interview 3). As such, Quickscan inventory outcomes, from which the pricing is calculated, sometimes mismatch (positive or negative) with the final inventory of secondary building components (Interview 3).

The Preparing & Sorting for transport supply process is often conducted to pre sort and protect the secondary building components.

Practices within the supply processes of the

Operational secondary building component supply processes from the 2dehandsbouwmaterialen.nl Circular building hub

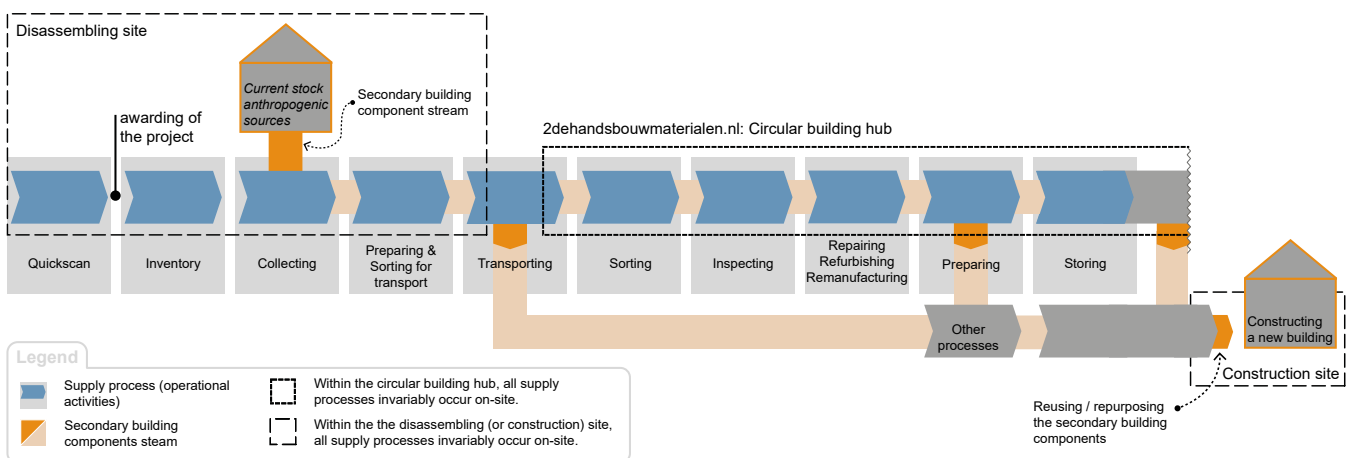


Figure 6-3: Illustrative overview of all the secondary building component supply processes based on the results of the case study analysis of 2dehandsbouwmaterialen.

2dehandbouwmaterialen CBH

"Appendix C – Tables of the practices" op pagina 130 provides a bundled overview (including bundled elements from all practices observed in all the case studies) of all practices that 2dehandbouwmaterialen.nl performs throughout the supply processes.

Case 4: Hoogeboom (Zwolle, Apeldoorn, and Raalte)

With the circular building hubs (CBHs) of Hoogeboom, the company launched several locations with logistical functions for circular building components: "Hoogeboom is in favor of a circular economy. This means, among other things, that we reuse the materials released during demolition work in their original function as much as possible" (Hoogeboom.nl, n.d.). Interestingly, the company combines these hubs with a waste drop-off station (a place where residents and businesses can deposit their waste): "We have a waste drop-off station, in Raalte, Zwolle, Apeldoorn and Enschede" (Hoogeboom.nl, n.d.).

Situated in Raalte, Zwolle, and Apeldoorn (all central to north-east in the Netherlands), their circular building hubs serve multiple purposes. First and foremost, the purpose of these hubs is to create central places for the storage and transshipment of secondary building components, and also for bridging the gap in time for finding a new purpose (Interview 6). Second, in the CBH, the performance of some preparatory work such as roughly removing nails, and sorting, are conducted before they are suitable for reuse (Interview 6). Third, their hubs serve as a market and showroom to present and sell their secondary building components to their buyers.

Since all hubs of Hoogeboom also function as waste drop-off stations, they distinguish between the reuse and recycling of building components (Interview 6). Moreover, their secondary building component can roughly be divided into two streams for reuse: 1) building components that require very minimal processing (only timber included), and 2) normal reuse of secondary building components. They prioritize reuse over recycling but are open to recycling if necessary

(Interview 6). For almost all secondary building components, the CBH plays a critical role in terms of bridging the gap in time for finding a new purpose. The first group 'minimal processing of building components' requires very minimal processing which mostly only refers to removing larger and more obvious nails from timber (Interview 6). The reason why Hoogeboom does not conduct any further preparation such as sanding and sawing timber, is because their customers don't request such alterations (Interview 6). The other reuse of secondary building components group involves secondary building components that do not require any repairing or other processing. Almost all secondary building components are sorted at their CBHs (Interview 6). Besides timber, most secondary building components are not processed, tested, or even inspected at the hub (Interview 6). As such, Hoogeboom aims to stick to its core business of demolition, dismantling, and selling raw building components to buyers (Interview 6).

The CBHs of Hoogeboom receive their secondary building components from their projects, private residents, and businesses because consumers or businesses deposit old building components at their waste drop-off station, and they retrieve those that are still profitable (Interview 6). Specialized disassembling teams ensure that the input from their projects meets higher standards (Interview 6). They select these teams because these employees find it more enjoyable to work on dismantling projects. Moreover, these employees possess the right skills and mindset (Interview 6). They also involve these colleagues actively in the entire process of what happens with secondary building components and actively encourage a patient and controlled approach to the work (Interview 6). At one of their hubs, they mostly have an employee permanently stationed to organize everything such as receiving buyers (Interview 6). Finally, Hoogeboom also employs "Saturday-guys" (Interview 6), which likely refers to (younger) employees working on Saturday such as students, who are involved in reducing labor costs.

The sale of secondary building components by Hoogeboom is conducted through their private online marketplace, which has an abundance of

photographs of all their components (Hoogeboom. nl, n.d.). In addition to its internal platform, Hoogeboom also utilizes Marktplaats.nl (Marktplaats B.V., n.d.) to sell its unique secondary building components such as kitchens and furniture. Private consumers (B2C) frequently visit their CBH's locations, as such, they are the main targeting audience for the company making up about 70% of their total client portfolio (Interview 6). As a result, they neatly sort many of their secondary building components on their hubs. Specifically utilizing certain divider racks for timber, organized on length and sizes. About 70-80% of their secondary building components are sold regionally (Interview 6). One reason for this might be that they have a limited focus on business (B2B) buyers. Finally, due to their focus on B2C, they try to needly organize their hubs (Interview 6). Moreover, Hoogeboom focuses mainly on raw building components, but also interior furnishings such as tables, desks, etc. (Hoogeboom. nl, n.d.).

In addition to these digital marketplace activities, Hoogeboom utilizes other digital tools, including a proprietary materials inventory app (Interview 6). Furthermore, because their hubs serve as a market and showroom to present the secondary building components, they utilize certain registration numbers (QR codes) to keep track of their secondary building components stored at their

hubs (Interview 6).

Supply processes of the Hoogeboom CBH

In contrast to the initial hypothesis regarding the arrangement and number of different supply processes, as established in the introduction of this research, the supply processes of Hoogeboom involve two extra processes: the 'Open viewing day', 'Quicksan', and 'Sorting for transport' processes, and neglects the 'Inventory' process (See Figure 6-4 on page 64)

Hoogeboom involves the 'Open viewing day' to minimize time spent on disassembling building components by the CBH while trying to maximize disassembling efficiency, potential financial returns, and reuse of secondary building components (Interview 6). The supply process is usually conducted directly after the project is awarded and before the Quicksan or Collecting processes.

The reason for organizing it directly after the project is awarded is that the site is not yet seen as an official 'construction/disassembling site'. As such, safety requirements are not yet necessary by law. As such, individuals without safety certificates can also visit the building that is prone to be disassembled (Interview 6). Likewise, the building and all components are still in good shape before wear and tear by weather or people can occur (Interview 6).

Operational secondary building component supply processes from the Hoogeboom Circular building hub

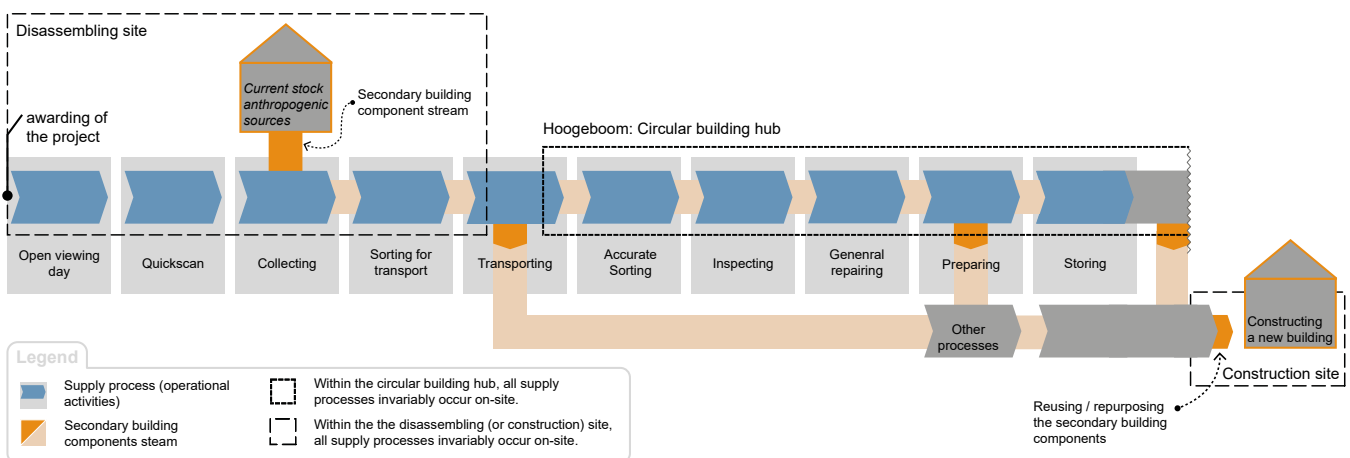


Figure 6-4: Illustrative overview of all the secondary building component supply processes based on the results of the case study analysis of Hoogeboom.

It includes embedded practices such as: 'Organizing an open viewing day', 'Performing a site visits and record (and communicating) the desired building components', 'Performing calculations and communicating with potential buyers from the open viewing day', and 'Pre-disassembling secondary building components (performed by buyers)'. In practice, after the project is awarded to the CBH, they organize a viewing day for all private individuals or organizations to 1) visit the disassembling site, 2) make a pre-order and bid on building components they are interested in, 3) disassemble the building components themselves, and 4) organize their individual transportation (Interview 6).

Hoogeboom involves the Quicksan supply process to gain a general idea about the potential secondary building components within the building structures (Interview 6). The main drive for performing the supply process is to develop a fitting disassembling plan.

The Preparing & Sorting for transport supply process is often conducted to pre sort and protect the secondary building components.

The Inventory process is neglected (Interview 6). This might be because of how they process the secondary building components at the CBH, which is mainly due to their focus on B2C sales. As a result, they are not required to have all the exact information on the secondary building components beforehand.

Practices within the supply processes of the Hoogeboom CBH

"Appendix C – Tables of the practices" op pagina 130 provides a bundled overview (including bundled elements from all practices observed in all the case studies) of all practices that Hoogeboom performs throughout the supply processes.

6.3 Comparative analysis between the case studies

Analyzing the results of the general mechanisms and characteristics of the four case studies, a few interesting observations were made. Starting with their commonalities: First, all CBHs are either

derived from a traditional demolition company, or in the case of 2dehandsbouwmaterialen, are a department of a larger demolition company. Moreover, these demolition departments are still their main business model.

Second, they all engage in both recycling and complete component reuse. As such, they all have a recycling department integrated in their business model or close contact with a recycling company. Complete component reuse is the preferred option for all, while recycling is ultimately employed to minimize waste. Several reasons were mentioned for this: First, because complete components reuse can be, depending on various factors, more profitable. Second, it is better to achieve certain sustainability goals. Third, the knowledge that is gained from these processes is valuable for optimizing the processes and preparing for future policy regulations (Interview 1, Interview 5, Interview 6).

Third, they all perform repair, remanufacturing, and/or refurbishing at the location of their CBH, rather than at the disassembling site. Interestingly though, they all prefer to sell everything from the disassembling site first, with only leftovers going to the Hub. To a certain extent, they all declare that this relates to transportation and processing costs (Interview 1, Interview 3, Interview 5, Interview 6.). Moreover, it was indicated by some CBHs that the majority of reusable secondary building components from their projects are directly transported to their buyers without much processing (Interview 1, Interview 5.).

Fourth, they all utilize inventory software throughout the supply process for various purposes such as conducting an inventory or Quicksan, calculating inventory differences, and creating a disassembling plan. Likewise, they all utilize a specific digital marketplace for construction materials (though they might use different platforms), next to the use of Marktplaats.nl. They likely utilize the latter due to its familiarity as a digital marketplace in the Netherlands.

Fifth, to some extent, they all employ their specialized disassembling teams/employees to ensure that the input from their projects meets higher standards, although not all teams of every CBH are yet fully employed with such

work. Moreover, they all stimulate and train their employees to work efficiently.

Finally, all CBHs accommodate both Business-to-Business (B2B) and Business-to-Consumer (B2C) buyers, although they usually have a stronger focus on one of these customer groups: "We prefer to focus primarily on business-to-business sales. While there will always be some business-to-consumer engagement, business-to-business is our preferred and more straightforward focus. It allows us to capture the largest quantity of opportunities" (Interview 5). Possibly, the geographical location could be a factor in why CBHs focus on the first or the latter. To explain, according to one interviewee, the geographical location factor, determining where a CBH is situated in the Netherlands, whether it's close to or within a major city in the western region (e.g. Amsterdam) or a more regional area (e.g., Overijssel), significantly influences how processes are structured (Interview 6). According to the interviewee, urban settings tend to prioritize aesthetics with products like wooden beams from popular stores like Gamma, whereas preferences vary more towards practicality in regional areas.

Next, differences between the hubs: Essentially, all CBHs aim for minimal interventions to restore secondary building components to minimize labor costs and thus reduce the pricing for secondary building components. Therefore, in almost all instances, the CBHs only perform minor alterations on timber components. However, there are differences when it comes to the performances of repairing, refurbishing, and remanufacturing: Hooigeboom focuses solely on removing larger and more obvious nails, while 2dehandsbouwmaterialen.nl, in specific cases, also sands timber products (1 mm sawing) while also performing minor sawing practices. Only ADEX Groep is routinely remanufacturing standard products of timber, while BORK Groep is not doing any refurbishing or remanufacturing practices at all, though they do remove nails from timber (repairing) and occasionally saw pieces of timber when they are extensively damaged. The results indicate that this distinction is influenced by their clients. The interviewee from Hooigeboom states that they do not perform any remanufacturing or refurbishing practices due to two reasons:

1) making them cheaper, and 2) often, their clients re-do the sawing into their specific lengths anyway after purchasing secondary building components. Hence, they prefer to have larger and cheaper pieces of timber. In the case of 2dehandsbouwmaterialen.nl, they accommodate this practice due to having a client like a hardware store that specifically requests such preparation. ADEX Groep has specific buyers for their 5 standard remanufactured timber components, and BORK mainly focuses on B2B sales which are less influenced by the visual appearance of their secondary building components.

Regarding the use of their marketplace activities, specifically Stichting Insert (the foundation; Insert Marktplaats), there are also differences. This might be attributed to the geographic location of the hubs and their sizes. For example, when Hooigeboom is asked why they do not use Stichting Insert they elaborate the following: *"We looked at that and decided based on experience to set it up ourselves, a marketplace. Because we see that 80% of the materials are not sold further than 15 or 20 kilometers from our hubs. So those marketplaces have a regional effect."* (Interview 6). Conversely, ADEX groep, for their digital marketplace activities solely relies on Insert Marktplaats. This might be because they are larger and more centrally positioned in the Netherlands, and have thus a larger customer group in the more densely populated western region.

An interesting observation relates to the elements of 'Motivation to reuse secondary building components' and 'Patience to do so' which are involved in many practices. To some degree, all hubs referred to that these are important skills to have when executing practices within the supply processes. For example, the interviewee from 2dehandsbouwmaterialen.nl states the following: *"A major challenge remains in motivating all the staff"* (Interview 3). When the interviewee is asked what measures are taken to do this, the interviewee states the following: *"I always try to motivate and enthuse them, and I think there's no better way than bringing ice creams and fries"* (Interview 3). Hence, these CBHs, originating from demolition business backgrounds, have established specialized practices to support these elements. This support

is known as the practice: 'Motivate, enthuse, and guide the disassembly team'. It's interesting that these companies, whose practices sometimes contradict their initial practices of swift demolition, have introduced a culture of careful disassembly and careful work. Although from a different perspective, it can also be seen that the CBHs return to some of their historical practices since some demolition companies originated from the idea of reusing secondary building components. For example, one interviewee elaborates the following about reusing secondary building components: "It has always been a revenue model, but that disappeared due to the large hardware stores" (Interview 5).

All CBHs emphasize the importance of communication throughout the supply processes with many stakeholders. The fact that all CBHs also simultaneously conduct demolition practices, next to disassembling of secondary building components, while these are often different teams, and that they all have partnerships with diverse companies, suggests that communication between these stakeholders is necessary. For example, one interviewee states: *"To get everyone involved in a company that is quite big, that's where the challenges lie"* (Interview 3). Another interviewee from ADEX Groep refers to that it is possible that sometimes two people, both from the demolition and dismantling teams, coordinate and communicate extensively at one disassembling site (Interview 2). Finally, the emergence of many more intermediaries in the sector, for example for refurbishing, renovating, and cleaning practices (Interview 7), suggests that the network of stakeholders is only getting more extensive, which might increase the importance of communication even further.

Two interviewees emphasized their involvement not only in the reuse of secondary building components but also in the broader aspect of "circular construction" (Interview 5, Interview 6). They discussed the importance of understanding how materials can be effectively reused in future construction projects. Their extensive knowledge and experience in demolition are invaluable when considering sustainable construction practices. For instance, Hoogeboom provided an illustrative

example involving square ceiling panels designed for easy disassembly. Engineers and clients often express interest in reusing these panels. However, in their experience, it was discovered that there is always a layer of dust on the top surface, and handling by disassembly personnel leaves fingerprints on the underside (which you see as the sealing of a room). These fingerprints couldn't be entirely cleaned, rendering the ceiling panels undesirable for future purchases. Hence, the knowledge these CBHs have is potentially valuable for circular construction purposes as well.

Only Hoogeboom and 2dehandsbouwmaterialen actively employ a registration system for their building components. Possibly, because they are currently more focused on B2C rather than B2B sales, and because they use their CBH location more actively as a showing room to present the secondary building components.

Finally, only Hoogeboom actively reuses secondary building components brought in by private residences, likely due to one of Hoogeboom's functions as a waste drop-off station. Possibly, because this may facilitate easier sorting of usable components and recycling and takes away the disassembling and transportation costs since these residences bring their old building components to them.

6.3.1 Re-establishing the operational secondary building component supply process

In contrast to the initial hypothesis regarding the arrangement and number of different secondary building component supply processes (supply processes), as established in the introduction of this research, the results indicate that there are two extra supply processes involved in the concept of a CBH since these were observed at multiple case studies. These are the 'Quickscan' and 'Preparing & Sorting for transportation' processes (See Figure 6-5 on page 68). Although these processes do not differentiate much from other existing processes, for example, the Quickscan involves many practices composed of elements comparable with practices in the Inventory supply process. Likewise, Preparing & Sorting for trans-

portation involves many practices composed of elements that are comparable with practices conducted at the hub, the results indicate that these supply processes are distinct from the others due to several factors. Henceforth, these supply processes are included separately.

A central differentiating factor that separates the Quicksan from the Inventory phase, apart from the fact that the latter is much more detailed, is that practices within the Quicksan are in most cases conducted before the project is awarded. Interviewee 5 describes this as the following: “We sometimes do it before a tender, so that is even before we get the contract. As such, we often have an inspection and then we don't do a very extensive inventory, but more a Quicksan, like: ‘What do I see and where do I see opportunities?’. So then afterward you [the hub] can include that in a tender. Only that is absolutely not detailed” (Interview 5). In other words, the main meanings that incentivizes practices within this supply process is that of winning the tender, which is an important and distinct element compared to the inventory phase. As a result, this supply process is taken into account.

The ‘Preparing & Sorting for transport’ supply process, which includes similar practices from the ‘Sorting’ and ‘Preparing’ supply processes, is

added following the pre-established conceptual framework. The reason for this is that the results indicate that some practices that would fall under either of these two, are likewise performed at the disassembling site and the CBH; sometimes within one supply chain sequence of a secondary building components within one CBH supply process. Likewise, due to financial reasons, the results indicate that most secondary building components are being sold directly from the disassembling site. As such, some of the practices involved are conducted at both locations.

Finally, the results indicate that next to minor deviations of other supply processes, there is one entire independent supply process possible: the ‘Open viewing day’ process. This supply process was indicated by the Hoogetoom. However, although it is potentially a useful supply process for the business concepts of CBHs, it is not included in this research as a general supply process, since embedded practices were only observed at Hoogetoom.

6.4 Core practices-as-entities in the supply processes

The results indicate a total of 37 core practices-as-entities (core practices) that are embedded

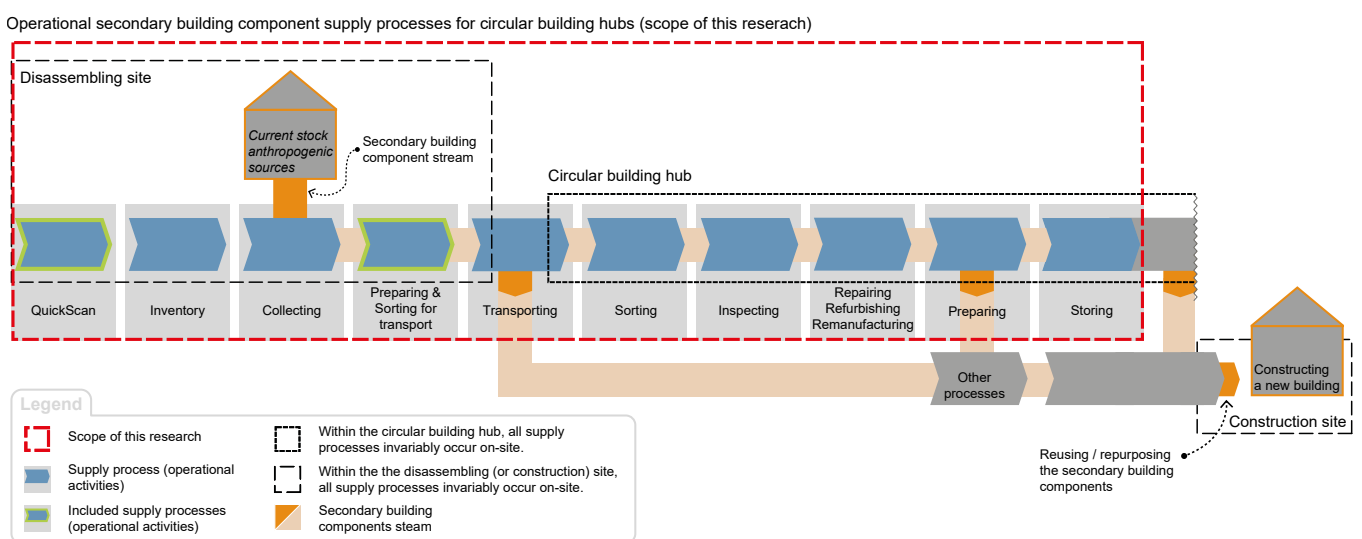


Figure 6-5: Illustration of the different practices and practices bundles existing within the supply process.

within or directly related to the supply processes of the general concepts of a CBH.

The core practices are divided into two groups:

- 1. Core practices embedded within the operational supply processes, and**
- 2. core practices directly outside the supply processes.**

For the core practices embedded within the operational supply processes, there is also an illustration that provides an overview in which supply process each of the practices are embedded ((See Figure 6-6 on page 70). For the other group, the practices are not always embedded specifically in one particular supply process since many of these practices are more general or can be conducted at multiple stages during the entire supply process. However, some are specifically conducted before, during, or after a particular supply process. Hence, when this is the case, the naming of the practices will convey these indications (See paragraph 6.4.1).

According to the conceptual framework, the core practices are those that are essential to the concept and thus the supply process of a CBH. These core practices have only been established when they were observed at multiple CBHs. As such, for each core practice, it is described how often these practices were observed in the four case studies. Consequently, the table of the practices in "Appendix C – Tables of the practices" op pagina 130 will convey how often this was observed ($n=x$). However, from Step 4 'Cross-verifying missing practices and elements' from the Data analysis phase 2 'Constructing the (core) practices-as-entities' multiple core practices have been cross-verified from other data points. As such, although some of these core practices were only observed at one CBH, the results indicate that there are a few core practices that must be conducted at multiple CBHs. Hence, these core practices have been indicated with an 'H' (hypothetical). These hypothetical indications were exclusively that certain practices required output from the performances of other practices in the supply process. For example, although the practice 'Write down the actual hours it took to disassembly secondary building components (after Collecting supply process)' was only mentioned

once, the practice 'Calculating differences between the inventory list and actual disassembled building components & calculate the time spend on disassembling of building components (after Collecting supply process)' requires the output from this practice. Consequently, the first practices must be conducted at multiple CBHs.

Although the 37 identified core practices are considered essential for the supply process of CBHs, the performances of these practices are dependent on the building components material types. For example, the practices of 'Sawing wooden secondary building components into new standardized sizes products (remanufacturing)' and 'Removing nails from wooden secondary building components (repairing)' are only conducted when timber building materials are processed. Moreover, it is not necessarily the case that each CBH always performs all of these core practices, since this may vary from project to project depending on factors such as available space, building components within the building structures, demands of the client, etc.

6.4.1 Describing the core practices-as-entities

The naming of the core practices is constructed to convey the most short, easy, and understandable meaning of the performances of the practices. A detailed description of these core practices, including all examined elements composing the practices, can be found in "Appendix C – Tables of the practices" op pagina 130.

Below is a list provided with the names of these practices, divided by the two groups:

Core practices embedded within the supply processes (See Figure 6-6 on page 70):

1. Conduct Quicksan inventory.
2. Perform detailed inventory, and create a list of potential secondary building components.
3. Disassemble secondary building components from building structures.
4. Pack/load disassembled secondary building components onto the small carrier.

5. Conduct visual (pre) inspection of secondary building components.
6. Remove secondary building components from building structures (carry, lift, push).
7. (Pre) sort secondary building components, place in various transport-racks for transportation.
8. Prepare secondary building components by wrapping, binding, stacking, and/or compressing.
9. Load secondary building components / carrying devices onto transport device.
10. Transport secondary building components to CBH, third parties, or clients.
11. Position the transport device on circular building hub.
12. Unload, sort, divide secondary building components into piles/locations or onto different carrying/storage devices.
13. Conduct a visual inspection of secondary building components.
14. Saw wooden secondary building components into (standardized) sizes (remanufacturing).
15. Remove nails from wooden secondary building components (repair).
16. Prepare secondary building components (stacked on carrier) for storage/transport
17. Create a detailed inventory list of secondary building components information.
18. Store secondary building components (indoors/outdoors) at the CBH.

Core practices directly outside the supply processes

1. Identify building component requirements by reaching out to potential buyers (before Quickscan)
2. Calculate potential profit margins (before Collecting)
3. Develop a disassembly plan, including time, location, logistics, and machinery (before Collecting)
4. Record actual disassembly time for building components (after Collecting)
5. Present potential inventory to buyers, track the sold building components (before/ during Collecting to Transporting)
6. List inventory on a marketplace (before/

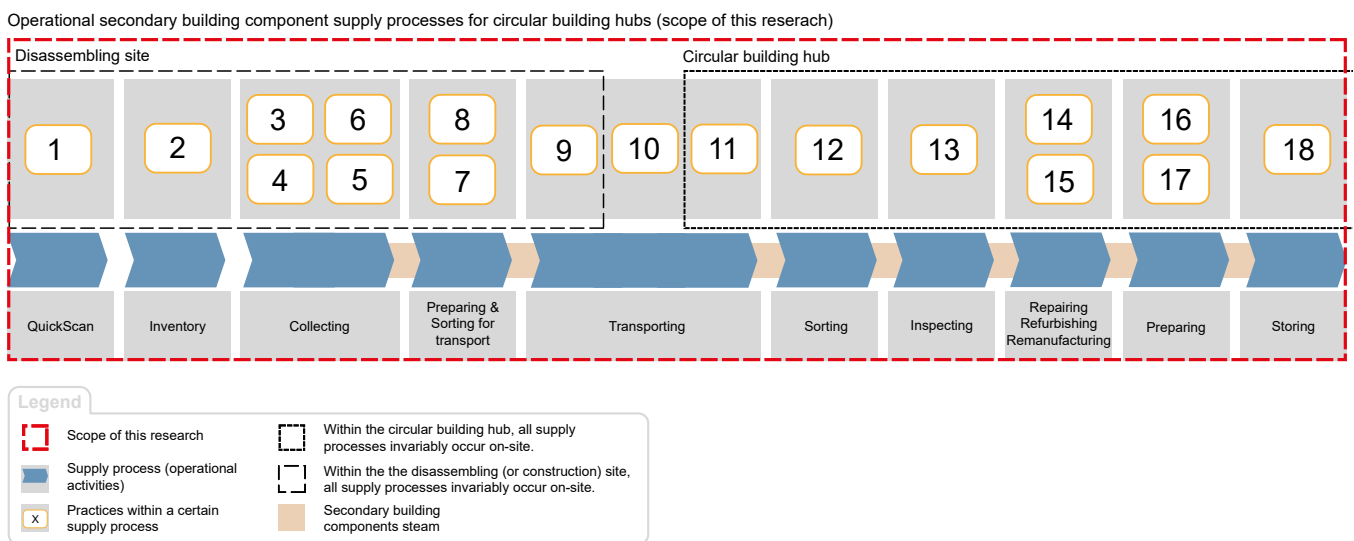


Figure 6-6: Illustrative overview of all the secondary building component supply processes and the core practices-as-entities that are embedded in them.

during Collecting to Transporting)

7. Motivate, enthuse, and guide the disassembly team (during Collecting to Transporting)
8. Create a transportation schedule (before Transportation)
9. List inventory on a marketplace (after Preparing)
10. Contact potential buyers to sell inventory (after Preparing)
11. Compare inventory list to disassembled components, calculate time spent (before Storing)
12. Monitor sales (before Storing)
13. Issuing an order for the disassembly (external companies, client) (before Quicksan)
14. Create upfront reuse inventory (client, external company) (before Collecting)
15. Plan and coordinate demolition site (external companies/internal) (before/during Collecting to Transporting)
16. Dismantle technical installations (external companies) (during Collecting)
17. Demolish the building (external companies/internal)
18. Place order for specific secondary building components (external companies, buyer)
19. Visit CBH to acquire potential secondary building components (external companies, buyer) (after preparation)

6.5 In-depth analysis of the core-practices-as-entities

This paragraph describes the in-depth analysis that was conducted on the results of the core practices-as-entities. The analysis is divided into three aspects: connections between core practices, shared elements, practice bundles, and general outcomes.

6.5.1 Connections between core

practices-as-entities

The results indicate vast and complex connections between the observed core practices; revealing the interrelated and interconnected nature of practices. Although all practices within the supply process have certain interconnectedness when observed from a more overall viewpoint, since they are all performed due to the broader context of the supply processes, not all practices are directly linked within each other. In other words, within the scope of this research, some practices have more autonomy or independence than others. Also, the way these practices are connected may be of a different nature. Consequently, for this research, the connections between the observed core practices have been divided into three groups, representing different connectives and influences. These are the following:

1. Direct sequential dependency: Some practices rely on the performance and outcomes of preceding practices, forming a sequence organized by time and/or space, without any practices in between. For example, the secondary building components must first be disassembled from the building structures before they can be packed or loaded onto small transport-racks. Another example, secondary building components first need to be loaded onto a transport device, before they can be transported to the CBH, third parties, or a client. From a more overall viewpoint, it is arguable that, for example, secondary building components also first need to be loaded onto a transport device before they can be stored at the CBH. However, for this analysis, only direct sequential dependency without the requirement of other practices in-between, is considered. As such, since practices of transportation and unloading first need to be performed before the storage of the components, this is not seen as a direct sequential dependency.

2. Direct performance influence: Some practices have potentially a direct influence on the performances of other practices. Although the performances of these subsequent practices are not necessarily interdependent on the preceding practices, the outcome of the first practice might have a direct impact on how elements are shaped or composed and actively integrated by the practi-

tioner performing the practice. As such, practices are directly influenced by when and where they are performed, and which or how elements are integrated in the performances. For example, the outcomes of the practice of the development of a disassembly plan have a direct influence on how and when other practices such as disassembling secondary building components from building structures are performed. In this example, the first practice may change the order or tools used to perform the second practice. Another example is that the placing of an order for specific secondary building components by an external buyer can have a direct influence on the performance of loading secondary building components onto small transport-racks. In this second example, the first practice can influence which transport-racks and how secondary building components are packed. Finally, some of these direct influences can also target specific elements. For example, in many cases, specific elements of the influencing practices play a role and often stimulate or motivate certain behaviors. For example, motivating and guiding the disassembly team has a direct influence on the performance of carefully loading the secondary building components onto a transport device.

3. No direct influence: Some practices are not directly influenced by other practices. Although all practices within the supply process have a certain interconnectedness when observed from an overall viewpoint, since they are performed due to the broader social context of the CBH, not all practices are directly linked to each other when considering the scope of this research. For example, calculating the potential profit margins (before Collecting) does not directly influence how the practice of storing secondary building components is performed.

In "Appendix D – Connections between core practices-as-entities" op pagina 152, applying these three different groups of connectives, the analysis regarding the connectives and influence between practices is conducted. The scoring of the practices are presented in Tabel 6-2 on page 73..

Scoring system

For easy visualizing and comparing the connectives between practices, a scoring system is

applied. When a practice is either direct sequential dependent on another practice, or its performance is directly influenced by another practice, a score of 1 is provided. As such, the scoring system reveals for each practice how many other practices it is influencing.

Scores were not provided for the practice 'Demolish the building (external companies/internal)'. Although this practice has a potentially large influence on the performances of other practices, it is entirely dependent on when this practice is performed (either before, during, or after other practices). As such, it is left out of the scoring.

A few practices can have both a Direct sequential dependency or a Direct performance influence from other practices. For example, according to the results, not all practices are always performed. For example, sometimes CBHs conduct a 'Quickscan inventory' without the performance of a 'Detailed inventory', or the other way around. Also depending on the material type, practices such as 'pack/load disassembled secondary building components onto small carrier' are not always performed since some components are removed from the building structures by hand and directly loaded into a transportation device. As a result, there can be a different influence. The Appendix shows with coloring when this is the case. However, they still score 1, since it cannot be both types of influences at the same time.

The results indicate that the practices 'Identify building component requirements by reaching out to potential buyers (before Quickscan) and 'Place order for specific secondary building components (external buyer)' are potentially influencing or forming a sequential dependency for most other practices. As such, they have the most connectedness with other practices.

6.5.2 Shared elements

The results indicate that there are a few shared elements that are embedded in multiple practices across multiple supply processes. The shared elements are described below, divided between materials, competences, and meanings.

Score	Core practices-as-entities
Core practices embedded within the supply processes:	
11	Conduct Quicksan inventory.
10	Conduct detailed inventory, create list of potential secondary building components.
7	weDisassemble secondary building components from building structures.
10	Pack/load disassembled secondary building components onto small carrier.
3	Conduct visual (pre) inspection of secondary building components.
4	Remove secondary building components from building structures (carry, lift, push).
8	(Pre) sort secondary building components, place in various transport-racks for transportation.
2	Prepare secondary building components by wrapping, binding, stacking, and/or compressing.
2	Load secondary building components / carrying devices onto transport device.
1	Transport secondary building components to CBH, third parties, or client.
1	Position transport device on circular building hub.
4	Unload, sort, divide secondary building components into piles/locations or onto different carrying/storage devices.
4	Conduct visual inspection of secondary building components.
0	Saw wooden secondary building components into (standardized) sizes (remanufacturing).
0	Remove nails from wooden secondary building components (repair).
3	Prepare secondary building components (stacked on carrier) for storage/transport
1	Create detailed inventory list of secondary building components information.
0	Store secondary building components (indoors/outdoors) at the CBH.
Core practices directly outside the supply processes	
19	Identify building component requirements by reaching out to potential buyers (before Quicksan).
2	Calculate potential profit margins (before Collecting).
12	Develop a disassembly plan, including time, location, logistics, and machinery (before Collecting).
0	Record actual disassembly time for building components (after Collecting).
0	Compare inventory list to disassembled components, calculate time spent (before storing)
0	Present potential inventory to buyers, track sold building components (before/during Collecting to Transporting).
1	List inventory on a marketplace (before/during Collecting to Transporting).
8	Motivate, enthuse, and guide the disassembly team (during Collecting to Transporting).
2	Create transportation schedule (before Transportation).
1	List inventory on a marketplace (after Preparing).
1	Contact potential buyers to sell inventory (after Preparing).
0	Monitor sales (before Storing).
6	Issuing an order for the disassembly (external companies, client) (before Quicksan).
5	Create upfront reuse inventory (client, external company) (before Collecting).
10	Plan and coordinate demolition site (external companies/internal) (before/during Collecting to Transporting).
1	Dismantle technical installations (external companies) (during Collecting).
ID	Demolish the building (external companies/internal).
19	Place order for specific secondary building components (external buyer).
3	Visit CBH to acquire potential secondary building components (after preparation) (external buyer).

Tabel 6-2: Overview of the core practices-as-entities and the scoring for each practice.

Materials

Inventory software

All CBH utilize inventory software (usually on a mobile phone) to conduct core practices within multiple processes, including the Quickscan, Inventory, and Collecting processes. Moreover, the inventory software, or the results from utilizing the material element during the Quickscan and Inventory processes, is used as input for many other practices, including but not limited to: 'Create a detailed inventory list of secondary building components information', 'Calculate potential profit margins (before Collecting)', 'Develop a disassembly plan, including time, location, logistics, and machinery (before Collecting)', and 'List inventory on a marketplace (before/during Collecting to Transporting)'. The software can include different sub-programs to stimulate other practices and the overall business strategy of CBHs such as photo functions, inventory tracking, CO² calculations, marketplace integration, and standard pricing lists. Hence, inventory software is an important and well-integrated material element that resides in the supply process.



Figure 6-7: Photo of the so called "bokken" used by the CBH.

Transport-racks for secondary building components such as 'bokken'

Multiple CBHs utilize certain smaller transport-racks such as "bokken" (see Figure 6-7 on page 74) to pack, transport, and store secondary building components (these were observed at ADEX Groep, BORK, and 2dehandsbouwmaterialen.nl) (similarly, sometimes crates, boxes, pallets were utilized with similar characteristics and purposes). These transport-racks, specifically the bokken, are used as a material element during the performance of multiple practices embedded in different supply processes. Moreover, these bokken shape the performance of many of these practices. To provide an example, one interviewee elaborates how they use these bokken: "Then they [the secondary building components] are taken out [from the building structures] with the crane and then outside, my colleagues stash them in the 'bokken'. Hence, these 'bokken' are material elements for the 'Pack/load disassembled secondary building components onto small carrier' and '(Pre) sort secondary building components, place in various transport-racks for transportation' practices. Moreover, placing multiple on a disassembling site allows for more detailed presorting practices to happen. When the interviewee is asked about why they use specifically those 'bokken' and not just one large container which seems more easily and space and weight efficiently, the interviewee elaborates the following: "*the bokken are a bit... you can see it all a bit better, so it's a bit more presentable, so to speak*". When the interviewee is asked if the improved sight on the building components is a motivation for enhancing the visual inspection, the interviewee answers: "That's right! That you can see it and also that when people come here they can see it immediately". Hence, these material elements also improve the performances of practices such as: 'Conduct visual inspection of secondary building components' and 'Create a detailed inventory list of secondary building components information'. Finally, the bokken shape practices performed during the Storing process: "And then the 'bokken' go... it is removed here [at the CBH] with the forklift truck and it is then immediately put in the shelter".

To conclude, the bokken are an important and well-integrated material element that resides in



Figure 6-8: Photo of the a lift fork truck used by a CBH.

different supply processes and practices such as sorting, packing, visual inspecting, and storing of the secondary building components.

Forklift (truck) (alternatively a lifting crane)

Similar to the bokken, the usage of crates, boxes, pallets, etc. enhances and shapes the performances of many practices performed in multiple supply processes. However, these material elements require specific handling. In practice, a forklift (truck) (alternatively a lifting crane) is needed to transport, load, and store these transport-racks (See Figure 6-8 on page 75). Hence, these material elements were observed in multiple supply processes and enhance and shape multiple practices such as: 'Remove secondary building components from building structures (carry, lift, push)', 'Load secondary building components / carrying devices onto transport device', 'Unload, sort, divide secondary building components into piles/locations or onto different carrying/storage devices', and 'Store secondary building components (indoors/outdoors) at the CBH'. Hence, the forklift (truck) (alternatively a lifting crane) is an important and well-integrated material element that resides in multiple supply processes and practices such as removing, packing, and storing the secondary building components.

Competences

Knowledge about which secondary building components are profitable to sell (Up-to-date pricing list for market pricing of secondary building components)

The knowledge about which secondary building components are profitable to sell is an important competence element that shapes multiple practices and has influences throughout multiple supply processes. For example, it is needed within the practices of 'Conduct Quickscan inventory', 'Perform detailed inventory, create a list of potential secondary building components', and 'Calculate potential profit margins (before Collecting)', since these practices require the practitioner to make an accurate guess as to where it is profitable to disassemble and process certain building components from the building structures. Hence, this competence element is closely linked to the competence element of 'Knowledge about accurate market pricing for building components'. Moreover, it is also embedded within the practices of 'Conduct visual inspection of secondary building components' and 'Present potential inventory to buyers, track sold building components'. For example, one interviewee mentioned when someone conducts a visual inspection, the practitioner needs to know when timber is still profitable to sell: *"Look, that's also about working efficiently. You might spend 1.00 hour on six nails, but then you could just as well say, hey, cut it off and grab a new piece. Yeah, that's somewhat related to cost and benefit"* (Interview 1).

This competence element can be seen as explicit knowledge (Cambridge Dictionary, n.d.-a), which can be formally collected and communicated. However, the results indicate that it is often gained through experience since some interviewees refer to that they just have the prices in their head, or they just know through experience how much time some things take, which ultimately affects the pricing. For example, when an interviewee is asked how the interviewee calculates the prices, the interviewee says: *"lots of prizes, I just know, but every now and then I look on the internet like: has something changed in the prices of a certain*

material". However, hereafter the interviewee says: "Yes, sometimes you have very specific things. Yes, you can't just put a price on that, no" (Interview 4,). Another interviewee states: "The Quickscan should mainly be about what is the value potential [...]". When asked if the interviewee needs specific knowledge for that, the interviewee continues: "Yes, that is a piece of knowledge and experience" (Interview 6). Hence, it is likewise a kind of tacit knowledge, which refers to the knowledge that is learned through experience and practice (Nonaka, 1998). Consequently, the results indicate that it is knowledge gained through many years of experience.

To conclude, the knowledge about which secondary building components are profitable to sell is an important and well-integrated competence element that resides in different supply processes and practices such as conducting Quickscans, conducting inventories, visually inspecting, repairing, and selling the secondary building components.

Knowledge of the demand of potential buyers regarding specifications for the secondary building components

The knowledge about the demand of potential buyers is an important competence element that shapes multiple practices and has influences throughout multiple supply processes. For example, it is needed within the practices of 'Conduct Quickscan inventory' and 'Perform detailed inventory, create a list of potential secondary building components', since these practices require the practitioner to make an accurate guess as to which building components are wanted by buyers. Moreover, it is also embedded within the 'Conduct visual inspection of secondary building components' and 'Present potential inventory to buyers, track sold building components'. Likewise, this knowledge can shape and enhance the performances of practices such as '(Pre) sort secondary building components, place in various transport-racks for transportation' and 'Prepare secondary building components by wrapping, binding, stacking, and/or compressing' depending on the demands.

Similarly to the competence element of 'Knowledge about which secondary building components are profitable to sell' this knowledge can be seen as explicit knowledge. However, the results indicate that it is often gained through experience and practice.

To conclude, the knowledge about the demand of potential buyers is an important and well-integrated competence element that resides in different supply processes and practices such as conducting Quickscans, conducting inventories, visual inspecting, preparing, and selling the secondary building components.

Patience for working carefully

Having the patience to work carefully is an important competence element that shapes multiple practices and has influences throughout multiple supply processes. For example, it is specifically needed within the practices of 'Disassemble secondary building components from building structures', 'Pack/load disassembled secondary building components onto small carrier', and 'Remove secondary building components from building structures (carry, lift, push)' since these practices are often conducted by practitioners who were used to work quick and rough due to their demolition work experiences.

It is not just that the practices themselves require a lot of patience, but the performances of the practices, with or without much patience, often affect the amount and quality of the secondary building components that are ready for reuse after the processes. This was also described by a few interviewees: 'You have to have patience. If you have someone who has no patience, they will ram over it and it will be broken' (Interview 5).

Other practices where patience for working carefully is needed due to the previously mentioned reasoning are: 'Load secondary building components / carrying devices onto transport device', 'Unload, sort, divide secondary building components into piles/locations or onto different carrying/storage devices', and 'Store secondary building components (indoors/outdoors) at the CBH'.

Meanings

Motivation for reusing (and selling) secondary building components and thus handling components carefully

Having the motivation to work carefully and efficiently with secondary building components is an important element that shapes multiple, if not most, practices and has influences throughout multiple supply processes. For example, it is needed within the practices of ‘Disassemble secondary building components from building structures’, ‘Pack/load disassembled secondary building components onto small carrier’, and ‘Conduct visual (pre) inspection of secondary building components.’ since these practices are often conducted by practitioners who were used to work quick and rough due to their demolition work experiences. It was mentioned by diverse interviewees that these employees sometimes lack this motivation which results in deficiencies in the performances of practices: *“One thinks second-hand building materials are beautiful and he will just walk his legs out from under his ass to ensure that we only get nice stuff. The other one is like, Yeah, I just think it’s bullshit, I’m just not going to do it”* (Interview 4,).

Motivation to make processes more efficient

Having the motivation to make the supply processes more efficient is an important element that shapes the performances of multiple practices and has influences throughout multiple supply processes. For example, it is needed within the practices of ‘Conduct Quickscan inventory’, ‘Perform detailed inventory, create a list of potential secondary building components’, ‘Disassemble secondary building components from building structures’, and ‘Record actual disassembly time for building components (after Collecting)’. It is not just that the practices themselves require a lot of motivation to make them more efficient, but the performances of the practices, with or without this motivation, often affect the amount and quality of the secondary building components that are ready for reuse after the processes. This was also described by a few interviewees (Interview 2.; Interview 3.).

6.5.3 Practice bundles

The results indicate that there are a few practice bundles within the supply process of CBHs. The practices within these bundles are often performed in a fluid and coordinated sequence by the same practitioner. Acknowledging and understanding how the practices within these bundles relate to one another helps with creating policies to enhance the performances of all the practices

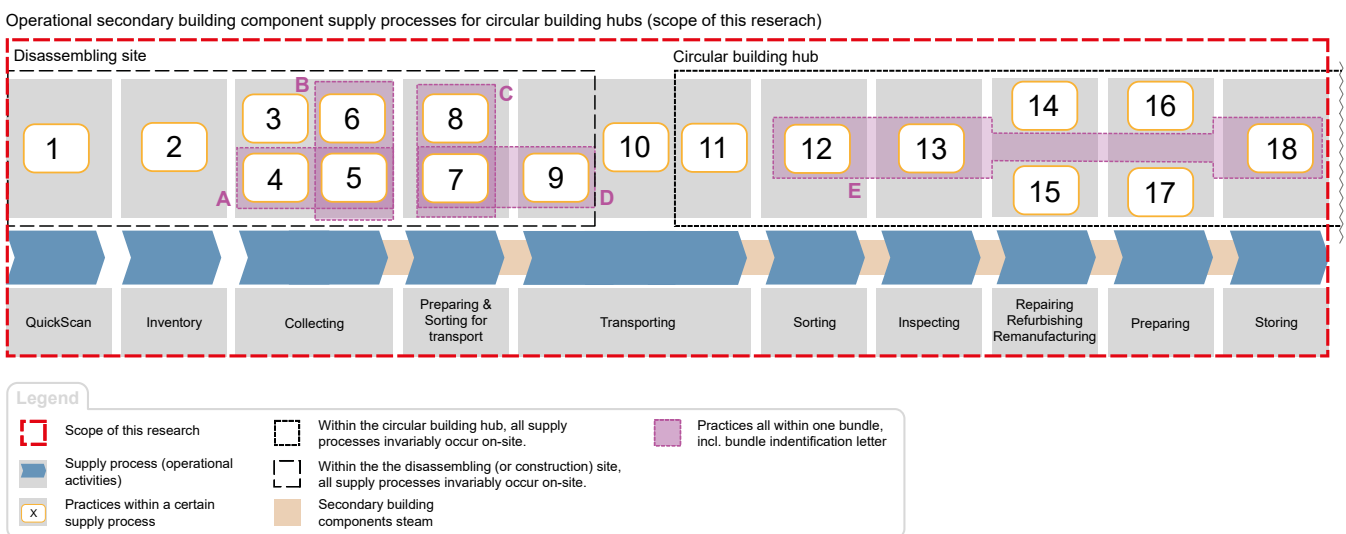


Figure 6-9: Illustrative overview of each practice bundle that was examined based on the data analysis of the core practices-as-entities located in the supply process.

Practice bundle: A	
Bundle performed in the supply process: Collecting	
Practice A1	Pack/load disassembled secondary building components onto small carrier.
Practice A2	Conduct visual (pre) inspection of secondary building components.

Practice bundle: B	
Bundle performed in the supply process: Collecting	
Practice B1	Remove secondary building components from building structures (carry, lift, push).
Practice B2	Conduct visual (pre) inspection of secondary building components.

Practice bundle: C	
Bundle performed in the supply process: Preparing & Sorting for transportation and Transportation	
Practice C1	(Pre) sort secondary building components, place in various transport-racks for transportation.
Practice C2	Prepare secondary building components by wrapping, binding, stacking, and/or compressing.

Practice bundle: D	
Bundle performed in the supply process: Preparing & Sorting for transportation and Transportation	
Practice D1	(Pre) sort secondary building components, place in various transport-racks for transportation.
Practice D2	Load secondary building components / carrying devices onto transport device.

Practice bundle: E	
Bundle performed in the supply process: Sorting, Inspecting and Storing	
Practice E1	Unload, sort, divide secondary building components into piles/locations or onto different carrying/storage devices.
Practice E2	Conduct visual inspection of secondary building components.
Practice E3	Store secondary building components (indoors/outdoors) at the CBH.

Tabel 6-3: Overview of the conducted observations for data collecting

within the bundles.

The observed bundles are the following (Tabel 6-3 on page 78 ;Figure 6-9 on page 77 which illustrates the bundles)

Although some bundles of practices exceed

the borders of the established supply processes, all the performances of the practices within the bundles are space-bound to a certain location. As such, bundles A, B, C, and D are only performed as bundles at the disassembling site and bundle E is only performed at the CBH.

All practices within a bundle are regularly and routinely performed in conjunction with each other, although this is dependent on the building component characteristics. Moreover, the building component characteristics often determine which practice bundle is performed. For example, if there is a certain large building component that does not fit on a carrier and thus needs to be carried by hand or lifting crane, Bundle B is performed instead of Bundle A. This is also the other way around when smaller building components are disassembled and stacked on a carrier. Consequently, it is noticeable that two practices can be part of multiple bundles.

Although it is the same for all practices, specifically, when practices within a bundle are well-coordinated, it can lead to smoother operations. For example, efficient packing (A1) and visual inspection (A2) in Bundle A can minimize delays and ensure that secondary building components are ready for transport outside or away from the building structures. Hence, practitioners seamlessly transition from loading disassembled secondary building components onto transport-racks to conducting visual inspections. This cohesion ensures that collected materials are immediately assessed for quality and suitability. Moreover, elements co-evolve during the performance of the practices within these bundles. For example, a defect identified during visual inspection (A2) in Bundle A can influence the decision to proceed with packing and loading (A1). Likewise, certain elements can enhance the performances of both practices. For example, directly loading secondary building components into a smaller box instead of a large open container, enhances the performance of conducting a visual inspection.

Similarly, Practice Bundles C and D, are centered around preparing, sorting for transportation, and packing onto a transportation device. Within both bundles, the timely understanding of where the secondary building components need to go (e.g. when half of the components need to be delivered directly to the buyer and the other half to the CBH) and whether certain preparatory work is necessary, can enhance the performances of the entire bundle and minimizes delays.

Practice Bundle E, covering sorting, inspecting,

and storing materials, highlights the importance of organized processing at the CBH. By systematically unloading, sorting, and visually inspecting secondary building components, the practitioner of these practices can maintain an efficient flow and performance of all three practices. Hence, when the practitioner is well equipped with the right knowledge, all performed practices can be enhanced simultaneously.

To conclude, there are a few practice bundles within the supply process of CBHs since the practices within these bundles are often performed in one fluid and coordinated sequence by the same practitioner.

6.5.4 General outcome: Self-improving feedback-loop system

The results indicate that there is a self-improving feedback-loop system within the supply process of CBHs. This can be observed within the elements of certain practices. It is not just due to the repeated performances of a single practice that it evolves, such as described in practice theory (Shove et al., 2012), but also due to the interconnectiveness between practices performed in a forward-linking sequence and the elements that provide an iterative learning process in reversed order (Figure

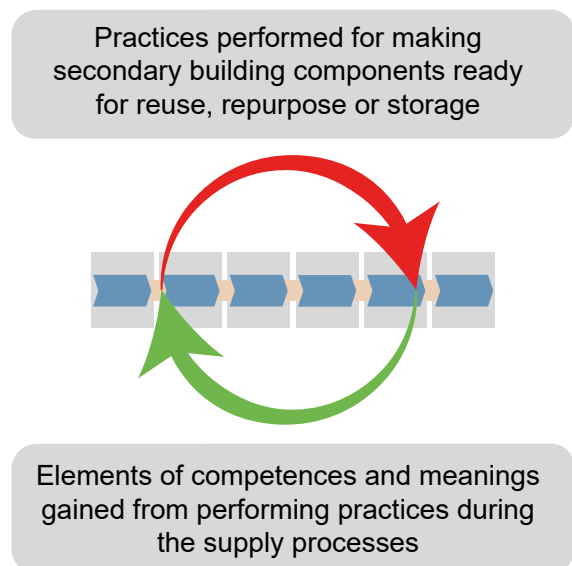


Figure 6-10: Illustrative overview of the Self-improving feedback-loop system within the supply process of CBHs.

6-10 on page 79). A result of this feedback-loop system is that practices within the supply process of CBHs that are linked by the elements, will improve when performed by the same practitioners, or when experiences from the performances of the practices are shared within the system. Hence, it highlights the interconnectedness of practices, competences, and meanings within the CBH context and how they contribute to an iterative learning process.

To provide an example, practices within the Quickscan and Inventory supply processes consist of competences elements such as: 'knowledge about the time needed for dismantling and preparing each potential building component' and 'Knowledge about which building components are profitable to dismantle from the building' and meanings elements such as: 'Motivation to make processes more efficient'. These elements are often acquired during and driven by practices within supply processes performed later on in the supply chain. For example, to understand the time that is needed for dismantling and preparing potential building components, one must either first perform practices of dismantling and preparing secondary building components or gain knowledge from others who have performed those practices.

Another example, practices within the Collecting, and Preparing & Sorting before transport supply processes consisting of competences elements such as 'Aim to make it as easy as possible, while being timely efficient, for preparing the secondary building components at the hub' and 'Knowledge about which building components need to be sorted' and meanings elements such as 'Drive for reusing secondary building components and thus handle components carefully' and 'Drive that pre-sorting the secondary building components and putting them on a carrying devices is more efficient in the entire supply process'. Likewise, these elements are in many cases also gained from performing practices that occur later on in the supply process.

Finally, a good example derives from one interviewee who specifically indicated that they train their employees at the hub to evolve a proper mindset and keen eye for performing practices at the disassembling site: "For us, it is of course

also that we train our staff, and those guys can go in all directions from here.". The interviewee later continues: "Because what we now see is that the guys who walk here [at the CBH] sometimes get the stuff delivered from demolition projects, and they then walk here swearing and saying 'jeez that doesn't work, you have to do that very differently [at the dismantling location]'. And with that inspiration, they go to a disassembling site and there they think: 'Hey you can do this much better like this, because then at the hub there is much less work to dismantle it further or for further use'. (Interview 1,)

To conclude, there is a self-improving feedback-loop system within the supply process of CBHs due to the interconnectedness between practices performed in a forward-linking sequence and the elements that provide an iterative learning process in reversed order.

6.6 Constraining and enabling factors

This paragraph describes the constraining and enabling factors. These factors are derived from the interviews, the comparative analysis between the case studies, and the in-depth analysis of the core practices-as-entities. Taking inspiration from Pomponi & Moncaster (2017), Densley Tingley et al. (2017), and Rakhshan et al. (2020), both the constraining and enabling factors are divided into the following categories: Organizational, Social, Economic, Regulatory, and Technical. Only the category Environmental is not included since this research did not find factors that can be categorized as such.

6.6.1 Constraining factors

In total, 29 different constraining factors have been identified. These factors are shown in Tabel 6-4 on page 81. Below, each factor is described.

Organizational

Too little time for the inventory/Quickscan phase.

The results from the interview data indicate that the Quickscan or inventory processes are

Constraining factors
Organizational
Too little time for the inventory/Quickscan phase.
Incorrect (too tight or too long in terms of time) disassembling schedule.
(Last minute) changes in the planning for the disassembling and demolition.
Secondary building components break during transport.
Too little time (to store) and space on the disassembling site.
Lack of space at the CBH (due to high costs).
Amount of actions required (or time needed) to prepare secondary building components for market sale.
Lack of knowledge regarding old building components inside the buildings (that are prone to being disassembled).
Lack of knowledge regarding detailed information of secondary building components.
Too high or wrong expectations regarding reusable secondary building components due to pre-inventory.
Social
Mindset of the demolition/disassembling workers.
Older secondary building components do not meet current demands.
Societal ideas about the quality of secondary building components.
Societal ideas about the pricing of secondary building components.
Lack of knowledge regarding the market of secondary building components or appropriate mindset by diverse stakeholders.
Economic
Supply of secondary building components inconsistency.
Uncertainty as to whether secondary building components will be sold.
Secondary building components are too specific (lack of knowledge about installations).
Uncertainty as to whether the (disassembling) project will be awarded.
Labor force scarcity in the labor market
Demand for custom-made building components by the construction sector.
Too large quantities of specific building components coming from large disassembling projects.
Lack of standardized sizes for secondary building components.
Regulatory
Laws and regulations, e.g., the 'Bouwbesluit.'
Buyers have to pay double taxes on secondary building components.
Lack of subsidies for secondary building components
Certification of employees and buyers (e.g., safety).
Technical
Dismantling buildings can lead to damaged building components.
Fragile secondary building components.

Tabel 6-4: Overview of the constraining factors divided by the categories: Organizational, Social, Economic, Regulatory and Technical.

sometimes too tightly planned in terms of the amount of time that is provided to perform a proper inventory (Interview 3). The potential consequences might be substantial since the inventory list is used throughout many practices within the supply processes. This constraining factor is closely connected to the factors of 'Incorrect disassembling schedule' which is caused by clients often providing a too tight schedule between the demolishing of a building and the construction of a new building (in the same place) (Interview 3, Interview 5).

Incorrect (too tight or too long in terms of time) disassembling schedule.

The results from the interview data indicate that the disassembling and demolishing of buildings often happen according to a 'demolition plan' that is prepared before the actual performance of the disassembling or demolishing (Interview 1; Interview 3; Interview 5; Interview 6). However, the extensiveness and integration of such plans within the process can vary. Such plans are sometimes too tightly planned in terms of the amount of time that is provided to extract (disassemble) secondary building components from buildings. According to the interviewees, there are several reasons for this: Clients providing a too-tight time schedule between the demolishing of a building and the construction of a new building (in the same place) (Interview 3, Interview 5, Interview 6), or there is too much time between the creation of the inventory list and the performance of the disassembling. As a result of this constraining factor, either secondary building components are neglected since there is too little time to disassemble them (Interview 3), or they are neglected since there was not enough time to find a buyer (Interview 1). Moreover, sometimes there is also too much time. This results in the disassembling team sometimes "forgetting" the exact inventory list and the disassembling plan which leads to inefficiencies (Interview 3). Finally, according to one interviewee, there is not enough communication between the disassembling and the construction processes within the building sector (Interview 6) which negatively influences this factor.

(Last minute) changes in the planning for the

disassembling and demolition.

The results from the interview data indicate that disassembling buildings often happens according to a 'demolition plan' that is prepared before the actual performance of the disassembling of components. The plan often describes a strict order regarding the performances of diverse practices. Moreover, for the disassembling of secondary building components specifically, an inventory list is created that describes all these components that are valuable for market sale. Also, many stakeholders are involved in the process of disassembling and demolishing buildings. Moreover, these processes are often tightly planned and leave little room for delay. As a result, according to one interviewee, the fact that multiple stakeholders are involved can lead to last-minute changes in the disassembling plan (Interview 2). Also, other factors such as last-minute changes by clients or building layout, or the presence of certain (toxic) building components can lead to changes (Interview 6). Consequently, this can lead to extra actions required to prepare or transport secondary building components, which in return can lead to financial deficiencies.

Secondary building components break during transport.

The results from the interview data indicate that the secondary building components often break during transport (Interview 6). This constraining factor is closely interwoven with, and also constructed by many other constraining factors such as the 'Too little time (to store) and space on the disassembling site', 'Mindset of the demolishing/disassembling workers' and 'Fragile building components'. As a result, this can lead to financial deficiencies, because the CBH loses money since time was invested in disassembling and preparing the secondary building components.

Too little time (to store) and space on the disassembling site.

The results from the interview data indicate that disassembling or construction sites are often very narrowly planned in terms of both time and space (Interview 1, Interview 3). Although this might be due to several reasons, it is beyond the scope of

this research to exactly pinpoint the reasons for this. However, this constraining factor has a negative effect on the following: transportation efficiency planning is more difficult (Interview 3), for example, to first bundle secondary building components and then transport them all at once. Moreover, it is difficult to perform a proper pre-sorting of all the secondary building components since there might be little space for different containers and trailers (Interview 3). This then leads to inefficiency since building components have to be packed twice. Also, time pressure makes it difficult to try out new methods of disassembling and innovating new approaches (Interview 1)

Lack of space at the CBH (due to high costs).

The results from the interview data indicate that at the location of the CBHs, there is often a lack of space scarcity (Interview 3, Interview 5). This constraining factor is closely connected to the 'Fragile building components', and 'Amount (or time needed) of actions required to prepare reusable building components for market sale' constraining factor. The first is because certain fragile building components demand a sheltered storage location, which is an even bigger problem due to financial reasons. The latter is because, as was also observed during the observations, lack of space often slows down supply processes and can also result in extra handling of the components due to relocating purposes.

Amount of actions required (or time needed) to prepare secondary building components for market sale.

The results from the interview data indicate that there are too many actions required (or time needed) to prepare secondary building components for market sale (Interview 1, Interview 3, Interview 5, Interview 6). Moreover, it is sometimes a result of other constraining factors such as 'Too little time (to store) and space on the disassembling site', 'Bad conditions of secondary building components', and 'Fragile building components'. As a result, within all case studies, the entire supply process is specifically designed to minimize the amount of time invested per building component. According to the interviewees, different factors are involved here,

for example, It is too time-consuming to extract components due to how they are attached to the building (e.g. glue or screws) (Interview 3), transportation of the components, either because of their dimensions or weight, makes it too time-consuming (Interview 5, Interview 6), and the location inside a building, which either requires specific equipment (e.g. telehandler) or makes transportation to time-consuming (Interview 2). As a result, reusable building components are sometimes neglected since this constraining factor can lead to financial deficiencies. What is important to mention, all CBHs either work directly or indirectly with people at a distance from the labor market. The results indicate that this is a deliberate choice to reduce labor costs in terms of the preparation of building components for market sale, although only one interviewee confirmed this (Interview 3).

Lack of knowledge regarding old building components inside the buildings (that are prone to being disassembled).

The results from the interview data indicate that there is still a (minor) lack of knowledge regarding the presence of certain secondary building components (Interview 1, Interview 5, Interview 6). This still occurs even though every CBH starts their project by investigating (Quickscan and/or Inventory). However, it is also mentioned that mostly, experience mostly leads to reasonably accurate estimations (Interview 5). This constraining factor could have different reasons, one of them mentioned is the following: Building components are behind a wall (Interview 2). This constraining factor has negative effects on the following: It makes it hard to properly plan for the time needed for the disassembling and estimate the quantities of usable secondary building components. Another aspect that was mentioned by one interviewee is that sometimes during the disassembling phase, toxic materials are discovered such as chromtrioxide (CrO₃) and or asbestos (Interview 6). This then leads to time deficiencies since specialized removal teams must first remove these materials.

Lack of knowledge regarding detailed information of secondary building components.

The results from the interview data indicate that (employees of) the CBHs often lack knowledge in terms of certain product characteristics and detailed knowledge (Interview 1,; Interview 5,). This lack of knowledge can be the carrying capacity, embodied carbon emissions of which CO₂ was mentioned (Interview 5), fire resistance (Interview 1,), and technological details and knowledge of certain technical installations, although all CBHs mention that they have other companies who are performing practices that require such knowledge. As a result, the CBHs are not able to certify many of their secondary components. However, those certifications are often needed for new construction works. Therefore, this constraining factor leads to trading difficulties. Although it was not mentioned specifically, the results indicate that the problem is not that such knowledge is difficult to obtain, but mostly that it is financially unattractive to invest in such knowledge since the margin on secondary building components is very low.

Too high or wrong expectations regarding reusable secondary building components due to pre-inventory.

The results from the interview data indicate that clients (mostly municipalities) already conduct an inventory before the involvement of the disassembling company or CBH (Interview 6). As a result, disassembling teams are forced to disassemble certain building components. This could be a problem since it might be that certain building components are necklaced, forced to be broken to disassemble the building components from the inventory list, or that the CBH ends up with building components that are hard to sell. Hence, according to the interviewee, there is not enough (practical) knowledge about the supply chain and market conditions regarding secondary building components by other stakeholders. This constraining factor is of course closely connected to the 'Lack of knowledge regarding the market of secondary building components or appropriate mindset by diverse stakeholders' factor.

Social

Mindset of the demolition/disassembling workers.

The results from the interview data indicate that the mindset of some individuals within the disassembly team can lead to inefficiencies or damaged building components in multiple steps of the supply process (Interview 2, Interview 3, Interview 5, Interview 6,). Henceforth, this constraining factor is closely connected to the 'Disassembling buildings can lead to damaged building components' and 'Building components break during transport' constraining factors. Often, the disassembly team members are the same people as the former demolishing workers, since all the CBHs examined started and partially still are demolishing companies (sloopbedrijven). Henceforth, as mentioned by the interviewees, the mindset of those former demolishing workers is often still smashing down buildings. As one interviewee describes it: 'As a demolishing worker you are used to grabbing a hammer and then you knock everything off the wall' (Interview 1). It is not only that their first instinct is to smash everything down, but it is also that those employees are used to working as fast as possible (Interview 1, Interview 6,), as this was their usual approach to demolishing projects. One interviewee also mentioned that some of those former demolishing workers are missing the patience of carefully disassembling building components; an important skill to have according to this interviewee (Interview 5). Finally, not all former demolishing workers are motivated to reuse building components as they do not always see the benefits or simply do not care (Interview 3).

Older secondary building components do not meet current demands

The results from the interview data indicate that older secondary building components do not always meet current demands (Interview 3, Interview 5,). This factor is closely connected with the constraining factor of 'Laws and regulations e.g. the Bouwbesluit'. However, according to the interviewees, constraining factors that arise with old building components are more extended. For example, societal constraining factors such as

trends (e.g. consumers do not like old-fashioned heaters anymore) (Interview 3) and the overall visual appearances of older building components (Interview 5) are resulting in trading difficulties. Others are that architectural and engineering practices have changed (e.g. older buildings often have lower doors and sealings) (Interview 2, Interview 5,) and technological advancements, which are also tied to sustainability goals, that lead to trading difficulties (e.g. fluorescent lighting vs LED lighting) (Interview 3).

Societal ideas about the quality of secondary building components.

The results from the interview data indicate that the idea in society about the lack of quality and performance of secondary building components is resulting in trading difficulties (Interview 1, Interview 2, Interview 6,). Hence, the image that secondary building components have is still undervalued in society (Interview 6). Explicitly it was mentioned that individual consumers often doubt quality when, for example, a piece of timber has a few tiny holes from nails (Interview 1, Interview 2,). However, such minor visual flaws do not have to affect the overall performance of building components. Finally, what does not help according to one interviewee, is that there are still not enough certifications for many secondary building components since there are still no official possibilities to do so due to a lack of laws and regulations (Interview 6).

Societal ideas about the pricing of secondary building components.

The results from the interview data indicate that the idea in society about the pricing of secondary building components is resulting in trading difficulties (Interview 1, Interview 2, Interview 5,). It was explicitly mentioned that consumers often expect the pricing of secondary building components to be much lower in comparison with new building components (Interview 1, Interview 2,). This constraining factor is closely interwoven with the constraining factor of the 'Societal ideas about the quality of secondary building components'. What does not help, as mentioned by one interviewee, is that new building components are still too cheap in comparison with secondary building compo-

nents (Interview 5). This might be due to the rise of the global economy which resulted in new building components have become relatively cheap in pricing. Hence, as one interviewee mentioned, the value for money in comparison with new building components from large construction markets makes trading with secondary building components difficult.

Lack of knowledge regarding the market of secondary building components or appropriate mindset by diverse stakeholders.

The results from the interview data indicate that other stakeholders such as clients sometimes lack knowledge regarding the supply chain and market conditions of secondary building components (Interview 3, Interview 6,). They are often unaware of some of the constraining factors such as the 'Amount (or time needed) of actions required to prepare reusable building components for market sale' which makes the pricing of building components financially unattractive, 'Laws and regulations' or that 'Old building components do not meet current demands' (Interview 3, Interview 6,). As a result, sustainability targets set by the client are often (financially) unachievable. According to the interviewee, this has to do with a lack of 'practical experience' from the client side. Also, as the interviewee mentioned, other stakeholders in the chain sometimes lack the motivation or enthusiasm for reusing secondary building components.

Economic

Supply of secondary building components inconsistency.

The results from the interview data indicate that there are inconsistency in the supply of secondary building components (Interview 5, Interview 6,). This factor is of course in line with the 'Too large quantities of specific building components coming from large disassembling projects'. However, as was mentioned by the interviewee, it also opposes a problem due to the 'Lack of space at the CBHs' constraining factor since this inconsistency results in a deficiency in the storage and preparation of building components at the CBH's location. Moreover, according to one interviewee,

this constraining factor affects the scalability of the hub since volume and consistency in the supply of secondary building components are required to grow (Interview 6). According to the same interviewee, this constraining factor is created due to a lack of appropriate disassembling projects

Uncertainty as to whether secondary building components will be sold.

The results from the interview data indicate that sometimes it takes too long for building components to be sold and potentially they will not be sold at all (Interview 5, Interview 6.). As a result, such components sometimes end up being dismantled and recycled (Interview 5). Although not mentioned specifically, this constraining factor, especially with the 'Lack of space at the CBHs', results in uncertainties as to whether secondary building components will be sold. As a potential result, certain reusable building components are neglected during the inventory and collecting phase.

Secondary building components are too specific (lack of knowledge about installations).

The results from the interview data indicate that some building components, mostly technical installations, are too specific. For example, they are specifically designed for the layout of the old building (Interview 5). This constraining factor is closely connected to the 'Demand for custom-building components by the construction sector' and 'Uncertainty as to whether secondary building components will be sold' constraining factors. Hence, as a result, such installations might be necklaced for reuse purposes. What does not help, according to the interviewee, is that employees of the CBH sometimes lack the knowledge to assemble the installations again at its new location. Besides, as mentioned by another interviewee, it can be vital that the individual disassembling such installations is the same person who is installing them again at the new locations since it requires the knowledge gained from disassembling them (Interview 2).

Uncertainty as to whether the (disassembling)

project will be awarded.

The results from the interview data indicate that uncertainties regarding whether the project will be awarded to the CBH or other rival companies can result in financial adverse consequences, and thus form a constraining factor (Interview 3). CBHs often perform a pre-inventory or Quicksan to determine for which price and possible discount they can apply for the tender of a project (Interview 2, Interview 3, Interview 5.). Moreover, they are sometimes asked in advance by the clients to determine if they can meet certain goals in terms of quantities of reusing building components. However, due to these uncertainties and the potential financial adverse consequences, this Quicksan is sometimes performed quickly. Henceforth, this can result in certain building components being overlooked or some are counted for but might be too time-consuming to disassemble (Interview 3). Henceforth, this can lead to inefficiencies in the disassembly plan. Also, there is not always time to re-visit the disassembly site in accordance with the constraining factor: 'Incorrect (too tight or too long in terms of time) disassembling schedule'.

Labor force scarcity in the labor market

The results from the interview data indicate that it is difficult to acquire new labor force due to the current (Dutch) labor market shortages (Interview 1, Interview 6.). This is backed by national scarcity (NOS Nieuws, 2022). More specifically, as mentioned by one interviewee, there is a lack of labor force with the appropriate skill set and mindset for carefully disassembling and handling building components (Interview 6)

Demand for custom-made building components by the construction sector.

The results from the interview data indicate that often architects design new buildings with building components that have custom-made sizes (Interview 1). However, it is often not possible to extract such building component sizes. This factor is also closely connected to the 'Laws and regulations' and the 'Old building components do not meet current demands' constraining factors. Also, although it is not mentioned specifically, from the

results it can be concluded that the factor 'Disassembling buildings can lead to damaged building components' is a reason why sometimes building components do not meet standardized dimensions, which makes them harder to reuse in new building design. For example, because nails or glue result in the fact that building components need to be shortened.

Too large quantities of specific building components coming from large disassembling projects.

The results from the interview data indicate that a CBH sometimes struggles with the amount of building components coming from a disassembly site (Interview 3). A specific example was provided that some large office buildings with 15+ floors can contain an extremely large number of window frames. About the 'Lack of space at the CBHs' constraining factor, this opposes storage challenges. Also, as was mentioned by the interviewee, for such large quantities it often takes time to find enough buyers.

Lack of standardized sizes for secondary building components.

The results from the interview data indicate that there is often too much variety with secondary building components in terms of sizes and dimensions (Interview 6). This is because the building components were specifically sized to fit with the old building layout. The interviewee mentioned that this is specifically the case with wooden building components. This results in the fact that it is difficult to extract and thus also offers standardized-sized building components to potential buyers. This constraining factor is of course closely connected to the 'Secondary building components are too specific', 'Old building components do not meet current demands', and 'Laws and regulations e.g. the 'Bouwbesluit'. Finally, what does not help is that many practices regarding designing new buildings are done with standardized-sized building components, and secondary building components do fit these criteria.

Regulatory

Laws and regulations, e.g., the 'Bouwbesluit.'

The results from the interview data indicate that law and regulations, and specifically the regulations from the 'Bouwbesluit', is a constraining factor (Interview 1, Interview 3, Interview 5, Interview 6.). The 'Bouwbesluit' (2012) is a regulatory framework (in the Netherlands) that regulates the technical requirements and standards for buildings (Zaken, 2010). It ensures different factors such as the safety, health, usability, energy efficiency, and environmental performance of construction/disassembling projects. The Bouwbesluit sets minimum standards for various aspects of a building, such as fire safety, structural safety, ventilation, sound insulation, energy performance, accessibility, and sustainability. Moreover, it is regularly updated to align with new developments, technical standards, and societal needs. These regulations often result in older types of secondary building components, for example, staircases or fire safety doors, or normal doors cannot be reused since either they do not meet the specifications described in the Bouwbesluit, or they do not have the corresponding papers required by the law (Interview 2, Interview 5.). Hence, this results in that they cannot be reused again for new construction projects, although they might be in good condition and were fully operational in the old buildings. CBHs thus have to neglect many of such building components, or they have trouble finding buyers. Another upcoming potential constraining factor that was mentioned is the new policy 'Wet Kwaliteitsborging' which will be launched in 2024 (Zaken, 2020). However, since this policy is not yet enacted, it is difficult to predict the exact (negative) effect on the supply processes.

Buyers have to pay double taxes on secondary building components.

The results from the interview data indicate that buyers have to effectively pay double tax on secondary building components (Interview 6). This makes, new building components in relation to secondary building components, cheaper.

Lack of subsidies for secondary building components

The results from the interview data indicate that there are no subsidies in the Netherlands for secondary building components, but there are for new building components (Interview 6). As a result, clients are often more likely to buy new building components. This is especially the case for isolation materials according to the interviewee.

Certification of employees and buyers (e.g., safety).

The results from the interview data indicate the lack of certification including safety wearing, often for safety reasons, both from employees of the CBHs and of the buyer of secondary building components (Interview 3, Interview 5). This factor is closely connected to the fact that many of the CBHs work with employees at a distance from the labor market, which is a direct result of the 'Amount (or time needed) of actions required to prepare reusable building components for market sale' constraining factor. It was mentioned that such employees sometimes lack the intellectual capabilities to receive certain safety certifications (e.g. VCA) (Interview 3). Also, some buyers are private individuals and have thus not always all the requirements for such safety certifications, or lack the appropriate safety clothing. This constraining factor results in the following: employees are not certified to remove certain technical installations, for example, the removal of air conditioning installations requires certain certifications (Ondernemersplein, n.d.), safety measures lead to time inefficiencies, or employees are not allowed on the demolition site at all. Moreover, to reduce the amount of actions required to prepare reusable building components for market sale, CBHs often sell their secondary building components directly from the disassembly site; directly after the 'packing for transport' operational process step. However, the fact that most private individuals lack certifications or safety wearing, creates a constraining factor to enact such strategies.

Technical

Fragile secondary building components.

The results from the interview data indicate that some types of building components are fragile

and therefore demand specific handling and tools (Interview 2, Interview 5). Moreover, some components cannot endure rain or other weather conditions (Interview 3). Although this constraining factor seems logical, in relation to other constraining factors such as the 'Mindset of the former demolishing workers', the 'Amount (or time needed) of actions required to prepare reusable building components for market sale', 'Disassembling buildings can lead to damaged building components', this constraining factor can oppose some challenges and can result in losses of revenue due to broken secondary building components.

Dismantling buildings can lead to damaged building components.

The results from the interview data indicate that dismantling buildings can lead to damaged building components (Interview 1, Interview 3, Interview 5, Interview 6). This has different reasons: disassembly teams proceeded to rough (Interview 2), building components break due to the use of machinery (Interview 3), older building components are often in worse conditions than newer building components and therefore break (Interview 2), building components have been glued (Interview 5, Interview 6), and sometimes building components are just old and rotten (Interview 6), etc. This constraining factor not only has a negative effect on the amount of secondary building components, but can also lead to negative effects concerning the relationship between the CBH and their clients or buyers. This is because building components sometimes are already sold before the disassembling itself and projects are based on agreements of targets for reusing certain quantities of building components (e.g. for sustainability goals).

6.6.2 Enabling factors

In total, 26 different enabling factors have been identified. These factors are shown in Tabel 6-5 on page 89. Below, each factor is described.

Organizational

Inventory software.

The results from the core practice data analysis

Enabling factors
Organizational
Inventory software.
Small transportation transport-racks like 'bokken' (or other similar stacking racks, boxes, etc.).
Forklift (truck) (alternatively a lifting crane)
Utilizing a digital marketplace (internally or externally organized).
Having a recycling option as a backup for recycling leftover building components.
Network of standard buyers for specific secondary building components that they can also dismantle themselves (collaborations).
The 'Reuse motivation bringer'.
Training and educating specific dismantling teams responsible for all dismantling work (initial training at the hub).
Employing workers at a distance from the labor market to reduce labor costs.
Establishing a large network in advance regarding diverse potential buyers for various secondary building components.
Knowledge about which secondary building components are profitable to sell.
Knowledge about the specific requirements of secondary building components from potential buyers.
Materials passports for buildings.
Increasing awareness among various stakeholders about the time required to disassemble and prepare secondary building components for reuse.
More space (and time) to store secondary building components at the demolition and disassembling site.
Social
Motivation to reuse/sell secondary building components (for all CBH employees).
Motivation to streamline the supply processes (for all CBH employees).
Patience to work carefully with secondary building components (for all CBH employees).
Economic
Increase in interest in secondary building components from the (business) market (due to rising costs of new materials and sustainability goals).
Rising costs of new construction materials that balance the price difference between new and reused construction components.
Earlier involvement of CBHs in the construction process.
Earlier involvement of CBHs in the disassembling process.
Effective and open communication among all stakeholders connected to the supply processes.
Directing the sale of secondary building components towards both business and private customers, but primarily focusing on one.
Regulatory
New NEN standard for steel (NTA8713).
Laws and regulations, including policies enforcing the implementation of sustainability goals in the construction sector.

Tabel 6-5: Overview of the enabling factors divided by the categories: Organizational, Social, Economic, and Regulatory.

indicate that inventory software (usually on a mobile phone) to conduct practices within multiple processes, including the Quicksan, Inventory, and Collecting processes, is an enabling factor. The software can include different sub-programs to stimulate other practices and the overall business strategy of CBHs such as photo functions, inventory tracking, CO² calculations, marketplace integration, and standard pricing lists.

Small transportation transport-racks like 'bokken' (or other similar stacking racks, boxes, etc.).

The results from the core practice data analysis indicate that smaller transport-racks such as "bokken" (see "Figure 6-7: Photo of the so called "bokken" used by the CBH." op pagina 74) to pack, transport, and store secondary building components, are an enabling factor. Also, sometimes crates, boxes, and pallets were utilized with similar characteristics and purposes.

Forklift (truck) (alternatively a lifting crane)

The results from the core practice data analysis indicate that a forklift (truck) (alternatively a lifting crane) for transport, load, and storing purposes, is an enabling factor. These transportation tools positively shape the performance of many practices.

Utilizing a digital marketplace (internally or externally organized).

The results from the core practice data analysis indicate that the use of a digital marketplace, which is often involved as early as possible in the process, is an enabling factor. The digital marketplace positively supports a crucial trade activity and thus the core business of the hubs.

Having a recycling option as a backup for recycling leftover building components.

The results from the core practice data analysis indicate that having an internal recycling branch directly linked to the main CBH operations or an external one related to these operations, is an enabling factor. Although reusing the entire building material product is preferable from several perspectives compared to recycling, the recycling

options provide opportunities to internally process leftover construction materials.

Network of standard buyers for specific secondary building components that they can also dismantle themselves (collaborations).

The results from the core practice data analysis indicate that a network or collaborations with specific buyers for, for example, technical installations that they can also dismantle themselves can promote supply processes and the reuse of secondary building components and is an enabling factor. Several circular building hubs are connected with such organizations. This network is in addition to having a network of (general) potential buyers for (general) building components.

The 'Reuse motivation bringer'.

The results from the core practice data analysis indicate that the practice: 'Motivate, enthuse, and guide the disassembly team (during Collecting to Transporting)' is an enabling factor. This factor is translated as: 'Reuse motivation bringer'. This is an important practice to stimulate elements such as 'Motivation to reuse/sell secondary building components (for all CBH employees) and 'Patience to work carefully with secondary building components (for all CBH employees)'. The results indicate that all CBHs are actively performing this practice. For example, the interviewee from 2dehandsbouwmaterialen states the following: "I always try to motivate and enthuse them, and I think there's no better way than bringing ice creams and fries" (Interview 3). The results indicate that this practice is important since all CBHs originate from demolition business backgrounds and that their practices sometimes contradict these elements since they usually focus on swift demolition.

Training and educating specific disassembling teams responsible for all disassembling work (initial training at the hub).

The results from the case study analysis indicate that training specific disassembling teams and specifically employing them on the disassembling project, with practical skills and qualities such as patience and motivation for reuse is an enabling factor. Moreover, the results indicate that there is

a self-improving feedback-loop system within the supply process of CBHs, due to the interconnect-edness between practices performed in a forward-linking sequence and the elements that provide an iterative learning process in reversed order. Consequently, starting to educate and train these disassembling teams at the hubs, involving processing, storing, and potentially selling the secondary building components, can help stimulate other elements like knowledge about specific buyer requirements, knowledge about which secondary building components are profitable, and motivation to streamline supply processes.

Employing workers at a distance from the labor market to reduce labor costs.

The results from the interview data indicate that the employment of employees at a distance from the labor market to reduce costs is an enabling factor (Interview 3). One interviewee states: "Yes, that takes more time. However, in our case, we have the advantage that we work with people who are at a distance from the labor market. So, they can be relatively affordable" (Interview 3). Moreover, the results indicate that multiple CBHs have taken similar approaches. At the CBH of Hoogeboom, they work with "Saturdayguys", which likely refers to (younger) employees working on Saturday such as students, who are also involved in reducing labor costs.

Establishing a large network in advance regarding diverse potential buyers for various secondary building components.

The results from the interview data indicate that an enabling factor is the pre-establishing of a large network of different potential buyers for diverse secondary building components (Interview 3, Interview 5). As such, this could be used during the Quicksan or Inventory phase and can result in earlier sales and direct transportation from the disassembly site. Similarly, this might result in more efficient processes which increases the quantity of reusable secondary building components while also increasing revenues for the CBHs. Finally, the results indicate that based on the portfolio of clients, certain practices can be stimulated which can enhance building component reuse. For example,

based on their client portfolio, the case studies conducted diverse practices such as refurbishing or remanufacturing timber building components (Interview 1, Interview 4.)

Knowledge about which secondary building components are profitable to sell.

The results from the core practice data analysis indicate that the knowledge about which secondary building components are profitable to sell positively is an enabling factor. A practical application can be an up-to-date pricing list for market pricing of secondary building components

Knowledge about the specific requirements of secondary building components from potential buyers.

The results from the core practice data analysis indicate that the knowledge about the demand of potential buyers is an enabling factor.

Materials passports for buildings.

The results from the interview data indicate that the use of material passports for the entire building is an enabling factor (Interview 5). One interviewee states: "What would also help is that during construction, a material passport is created, [...] Well, then all the information about what's in that building can already go to the party that will be disassembling it, and they can say, 'In two years, this and this will become available. Yes, that's the ideal world as I envision it'" (Interview 5). As a potential result, this information could be of value in creating an inventory list and disassembling a plan far in advance, which will make the supply processes more efficient.

Increasing awareness among various stakeholders about the time required to disassemble and prepare secondary building components for reuse.

The results from the interview data indicate that the increase in the awareness of different stakeholders regarding the time needed to disassemble and prepare secondary building components is an enabling factor (Interview 5). One interviewee states: "some clients are indeed willing to

allocate more time for that or sometimes even willing to pay for it. So, that's a development that is emerging, you could say, and it's ongoing. Yes, definitely." (Interview 5). As a result, there is more time to properly conduct diverse practices within different supply processes, leading to more efficient processes which increases the quantity of reusable secondary building components while also increasing revenues for the CBHs.

More space (and time) to store secondary building components at the demolition and disassembling site.

The results from the interview data indicate that having more space at the disassembling site since this would allow to (temporarily) store building components on the construction site, is an enabling factor (Interview 3). Moreover, the results indicate that there is often a lack of space at the construction site, though more space would increase many practices within the supply processes of sorting and preparing for transport. Also, since all CBHs perform repair, remanufacturing, and/or refurbishing at the location of their CBH, though simultaneously they all prefer to sell everything from the disassembling site first, with only leftovers going to the CBH, more space at the disassembling site might provide the opportunity to conduct those practices there. Finally, it would make transportation costs more efficient.

Social

Motivation to reuse/sell secondary building components (for all CBH employees).

The results from the core practice data analysis indicate that having the motivation to work carefully and efficiently with secondary building components, is an enabling factor. This motivation positively shapes the performance of many practices.

Motivation to streamline the supply processes (for all CBH employees).

The results from the core practice data analysis indicate that having the motivation to make the supply processes more efficient is an enabling factor. This motivation positively shapes the perfor-

mance of many practices.

Patience to work carefully with secondary building components (for all CBH employees).

The results from the core practice data analysis indicate that having the patience to work carefully is an enabling factor. This skill positively shapes the performance of many practices.

Economic

Increase in interest in secondary building components from the (business) market (due to rising costs of new materials and sustainability goals).

The results from the interview data indicate that the increase in interest in secondary building components from the business market is an enabling factor (Interview 5, Interview 6.). The results indicate two reasons for this. First, reusing secondary building components "is slowly becoming a revenue model again", partially because "it's going to get cheaper [in comparison to new materials, since] [...] raw materials are going to get more expensive" (Interview 5). The other reason is that companies have to invest due to certain circularity or sustainability goals that must be achieved, since, as the same interviewee states, "they can give substance to it in this way" (Interview 5). As a result, there is a growing demand for secondary building components. As such, CBHs have a larger sales market and increasing revenues.

Rising costs of new construction materials that balance the price difference between new and reused construction components.

The results from the interview data indicate that the increase in costs for new building components, which results in a growing demand for secondary building components, is an enabling factor (Interview 5, Interview 6.). As such, CBHs have a larger sales market and increasing revenues.

Earlier involvement of CBHs in the construction process.

The results from the interview data indicate that the earlier involvement of the CBH in the

construction phase of construction projects is an enabling factor (Interview 5). "And in the beginning of a construction process, we are sometimes asked as well, so we end up in construction teams where it's like, 'We're going to build this, but in fifty years, it needs to come apart.' 'How can we build that in the best way? [...] 'How easy should the disassembling of things be?' 'What materials can we use for that?' 'Can we use circular materials for that, for example?' So, our [role] changes in that regard. [...] we do take on an additional role, and that's great." (Interview 5). The results indicate that this earlier involvement can be advantageous since the CBHs have a lot of knowledge that can improve design for reuse practices. As a result, in the future, those building structures are potentially easier to disassemble. This might make the whole supply process for CBHs in the future more efficient.

Earlier involvement of CBHs in the disassembling process.

The results from the interview data indicate that the earlier involvement of the CBH in the disassembling project is an enabling factor (Interview 2). This might allow for the potential secondary building components to be known as early as possible which results in more time to find potential buyers. Moreover, this might make the whole supply process more efficient since it could result in better disassembling planning.

Effective and open communication among all stakeholders connected to the supply processes.

The results from the case study analysis indicate that effective and efficient communication among all involved stakeholders (such as clients, buyers, demolition teams, disassembling teams, technical disassembling experts, etc.) during the supply processes is an enabling factor. Given the narrow profit margins, miscommunication can lead to losses.

Directing the sale of secondary building components towards both business and private customers, but primarily focusing on one.

The results from the case study analysis

indicate that focusing on sales in both the private sector (B2C) and the professional sector (B2B) can potentially expand the customer portfolio and is an enabling factor. While some hubs argue that B2B is more efficient due to often involving larger quantities and easier communication, a mix of B2C and B2B can be beneficial. Not all secondary building components are used by businesses, and it was also suggested that B2C yields higher revenue. Therefore, combining B2B and B2C could be a good option. However, maintaining a primary focus on one of these categories is important, as customer focus greatly influences the setup of practices in supply processes. For example, the results indicate that based on the portfolio of customers, certain practices are conducted that require the right contextual conditions and employees. For example, based on their clients portfolio, the case studies conducted diverse practices such as refurbishing or remanufacturing timber building components (Interview 1, Interview 4.)

Regulatory

New NEN standard for steel (NTA8713).

The results from the interview data indicate that the new NEN-norm for steel (NTA8713) (Interview 6) is an enabling factor. NEN-normen, a national standardized norm for technical specifications and guidelines for various aspects of building materials, structures, and processes (Home - NEN, n.d.), offers possibilities to certify secondary construction materials, thus, making them more attractive to potential buyers and leading to a greater quantity of reusable secondary construction materials.

Laws and regulations, including policies enforcing the implementation of sustainability goals in the construction sector.

The results from the interview data indicate that an increase in laws and regulations including policies that force the implementation of sustainability goals in the construction sector is an enabling factor (Interview 1, Interview 3, Interview 5, Interview 6.). As a result, there is a growing demand for secondary building components. As such, CBHs have a larger sales market and an increase in

revenues.

6.7 General insights into the influence of the constraining and enabling factors

This paragraph elaborates on the results regarding the general insights into the influence of the constraining and enabling factors on the scalability of the core practices-as-entities (core practices). These results are based on the first data set 'The scoring table: Frequency and influence' derived from the FGD (See "Appendix E - The scoring table: Frequency and influence (1/2)" op pagina 153). These results are divided into influence of the 1) constraining factors and 2) enabling factors. After the impact scores are provided, the results from analyzing these data reveal some nuanced insights.

Scoring system

The total influences (now referred to as impact class) from the factors on the scalability of the core practices are based on two indicators: 1) how often the factors are encountered within the supply processes (frequency of the factors), and 2) how large in the effects are when the factors are encountered within the supply processes (influence of the factors). For each factor, the different contributors scored 0, 1, 2, or 3 on the two indicators. Scoring 0 is no frequency or no influence and scoring 3 is high frequency or high influence. The total calculated impact class of each factor on the scalability of the core practices is based on total allocated scores. 0 is the lowest impact and 30 is the highest impact. Hence, this includes both frequency and influence scores per contributor (total of 5). These total allocated scores are divided into three impact classes: low, medium, and high. The impact class is calculated based on an original distribution with the lowest scoring (0) and highest scoring (30) and then divided by three. As a result, all factors with a total score of 0 – 10 scored low, 11 – 20 scored medium, and 21 – 30 scored high.

This scorings system was intentionally applied, instead of for example a system based on restricted distribution, since the scores were only based on

4 variables. As such, there was no absence of any insights since this provides a more comprehensive understanding of the variability within the data.

Next to the impact classes, the color saturation reveals a more nuanced impact difference. The deeper the color of red, the more impact of the constraining factor. Similarly, the deeper the color of green, the more impact of the enabling factor. Still, it is important to note that results are only general insights and the impact of each factor is more nuanced.

Missing data

In a few instances, the participants in the focus group and all other contributors of the 'The scoring table: Frequency and influence' did not know a certain factor. As a result, there are a few missing values within the data set (missing scores on frequency or influence). To mitigate the influence of the empty results, an imputation method is used. Because the percentage of missing data is low, and the input data is only based on 4 values (0,1,2, and 3), the natural variation of the results is still high enough to present an effective model when imputation is utilized.

The imputation method is based on the mean of the total count from the variables (frequency and influence) regarding that specific factor. Only when the data is missing at random, meaning that the data is missing relative to the observed data (edX.org, n.d.), an imputation is conducted. In other words, the data is not missing across all observations but only within sub-samples of the data. However, focusing on the highest validity possible, this method was only applied when in an entire data row, there was a maximum of one missing value.

For one constraining and one enabling factor however, 'Lack of subsidies for secondary building components' and 'Earlier involvement of CBHs in the construction process' respectively, the data is missing across multiple (75% and 50%) variables. Therefore, the portion of missing data is too high, and applying imputation will result in biased results. As such, the whole factor (variable) is deleted from the data analysis regarding the influence.

Constraining factors	Category	Impact class	
Certification of employees and buyers (e.g., safety).	Regulatory	Low	
Secondary building components break during transport.	Organizational	Medium	
Uncertainty as to whether the (disassembling) project will be awarded.	Economic	Medium	
Fragile secondary building components.	Technical	Medium	
Lack of knowledge regarding old building components inside the buildings (that are prone to being disassembled).	Organizational	Medium	
(Last minute) changes in the planning for the disassembling and demolition.	Organizational	Medium	
Lack of space at the CBH (due to high costs).	Organizational	Medium	
Lack of standardized sizes for secondary building components.	Economic	Medium	
Mindset of the demolition/disassembling workers.	Social	Medium	
Demand for custom-made building components by the construction sector.	Economic	Medium	
Societal ideas about the quality of secondary building components.	Social	Medium	
Too large quantities of specific building components coming from large disassembling projects.	Economic	Medium	
Incorrect (too tight or too long in terms of time) disassembling schedule.	Organizational	Medium	
Too high or wrong expectations regarding reusable secondary building components due to pre-inventory.	Organizational	Medium	
Too little time for the inventory/Quickscan phase.	Organizational	Medium	
Dismantling buildings can lead to damaged building components.	Technical	Medium	
Too little time (to store) and space on the disassembling site.	Organizational	Medium	
Lack of knowledge regarding the market of secondary building components or appropriate mindset by diverse stakeholders.	Social	High	
Supply of secondary building components inconsistency.	Economic	High	
Labor force scarcity in the labor market	Economic	High	
Secondary building components are too specific (lack of knowledge about installations).	Economic	High	
Amount of actions required (or time needed) to prepare secondary building components for market sale.	Organizational	High	
Lack of knowledge regarding detailed information of secondary building components.	Organizational	High	
Older secondary building components do not meet current demands.	Social	High	
Societal ideas about the pricing of secondary building components.	Social	High	
Uncertainty as to whether secondary building components will be sold.	Economic	High	
Buyers have to pay double taxes on secondary building components.	Regulatory	High	
Laws and regulations e.g. the 'Bouwbesluit'	Regulatory	High	
Lack of subsidies for secondary building components	Regulatory	ID	ID

Tabel 6-6: Overview of the influence of the constraining factors. Including an indicative impact class based on low, medium, or high.

6.7.1 Constraining factors

The results indicate the following influences of the constraining factors on the scalability of the core practices (See Tabel 6-6 on page 95 ;see "Appendix E - The scoring table: Frequency and influence (1/2)" op pagina 153 for the full scoring overview):

Analysis of the constraining factors

The analysis of the results reveals some nuanced insights.

First, although the factors 'Secondary building components are too specific (lack of knowledge about installations)' and 'Supply of secondary building components inconsistency' fall under the high impact class, their average score on 'influence' is 2.0 and 2.2 respectively, and their frequency score is 3.0. Consequently, although they have a high frequency, the factor may not always have a high impact on the scalability of the supply processes.

Second, the factors 'Too high or wrong expectations regarding reusable secondary building components due to pre-inventory and 'Lack of standardized sizes for secondary building components' fall under the medium impact class, but their average influence score is 2.8 and 2.6, and their average frequency score is 1.0. Consequently, although they have a low frequency, these factors could have a high influence when they do occur.

6.7.2 Enabling factors

The results indicate the following influences of the enabling factors on the scalability of the core practices (See Tabel 6-7 on page 9699 ;see "Appendix E - The scoring table: Frequency and influence (1/2)" op pagina 153 for the full scoring overview).

Analysis of the enabling factors

The analysis of the results reveals some nuanced insights. First, based on the original distribution of the impact classes there are no enabling factors scoring 'Low'. Second, although the factor 'Earlier involvement of CBHs in the disassembling process.' falls under the high impact class, the average score on 'influence' is 1.8. Consequently,

although it has a high frequency, the factor may not always have a high impact on the scalability. Also, although the factor 'Rising costs of new construction materials that balance the price difference between new and reused construction components' falls under the high impact class, the average score on 'frequency' is 1.6. Consequently, although it has a high influence, the factor only has occasionally a higher impact on the scalability.

Second, the factor 'Motivation to reuse/sell secondary building components (for all CBH employees)' falls under the medium impact class. However, the average influence score is 3.0 and the average frequency score is 1.3. Consequently, although they have a low frequency, these factors could have a high influence when they do occur.

6.8 Group discussion about the influence of the constraining and enabling factors

This paragraph elaborates the results from the 'General discussion on the influence of the factors' data, derived from the FGD. These results reveal some more in-depth insights regarding the influence of the constraining and enabling factors on the scalability of the core practices. These results are structured in the following aspects: client motivations, employee mindset, architect involvement, sustainability goals, local vs. regional scale, subsidies, labor costs, materials passports, sales focus, networks, communication, and emerging policies.

Client influence

Insights from the FGD revealed that the extent of influence of certain factors is affected by the clients CBHs serve. Clients with strong motivations for reusing secondary building components can significantly affect which factors come into play or how large their influence is on the scalability of the

Tabel 6-7: *Overview of the influence of the enabling factors. Including an indicative impact class based on low, medium, or high.*

Constraining factors	Category	Impact class	
New NEN standard for steel (NTA8713).	Regulatory	Medium	
More space (and time) to store secondary building components at the demolition and disassembling site.	Organizational	Medium	
The 'Reuse motivation bringer'.	Organizational	Medium	
Increase in interest in secondary building component from the (business) market (due to rising costs of new materials and sustainability goals).	Economic	Medium	
Patience to work carefully with secondary building components (for all CBH employees).	Social	Medium	
Motivation to reuse/sell secondary building components (for all CBH employees).	Social	Medium	
Motivation to streamline the supply processes (for all CBH employees).	Social	High	
Rising costs of new construction materials that balance the price difference between new and reused construction components.	Economic	High	
Employing workers with a distance to the labor market to reduce labor costs.	Organizational	High	
Increasing awareness among various stakeholders about the time required to disassemble and prepare secondary building components for reuse.	Organizational	High	
Laws and regulations, including policies enforcing the implementation of sustainability goals in the construction sector.	Regulatory	High	
Having a recycling option as a backup for recycling leftover building components.	Organizational	High	
Training and educating specific dismantling teams responsible for all dismantling work (initial training at the hub).	Organizational	High	
Earlier involvement of CBHs in the disassembling process.	Economic	High	
Knowledge about which secondary building components are profitable to sell.	Organizational	High	
Inventory software.	Organizational	High	
Materials passports for buildings.	Organizational	High	
Network of standard buyers for specific secondary building components that they can also dismantle themselves (collaborations).	Organizational	High	
Utilizing a digital marketplace (internally or externally organized).	Organizational	High	
Directing the sale of secondary building components towards both business and private customers, but primarily focusing on one.	Economic	High	
Effective and open communication among all stakeholders connected to the supply processes.	Economic	High	
Establishing a large network in advance regarding diverse potential buyers for various secondary building components.	Organizational	High	
Forklift (truck) (alternatively a lifting crane)	Organizational	High	
Small transportation transport-racks like 'bokken' (or other similar stacking racks, boxes, etc.).	Organizational	High	
Earlier involvement of CBHs in the construction process.	Economic	ID	ID
Knowledge about the specific requirements of secondary building components from potential buyers.	Organizational	ID	ID

supply processes. For example, it was mentioned that the following constraining factors were less impactful from the experience of Stichting Insert in contrast to the other participants representing two of the CBHs:

- ⌘ Too little time for the inventory/Quickscan,
- ⌘ Too high or wrong expectations regarding reusable secondary building components due to pre-inventory
- ⌘ Lack of knowledge regarding the market of secondary building components or appropriate mindset by diverse stakeholders
- ⌘ Demand for custom-made building components by the construction sector,

It became evident that this difference was related to the client portfolio of Stichting Insert. These clients are often more involved with a stronger motivation for reusing secondary building components. In contrary, the client portfolio of the other participants of the FGD is different. As a result, some of the identified factors are more frequently occurring and have a larger impact on the cases from this research. A possible explanation is that the case studies in this research are all also a demolition company next to activities regarding the supply processes for their CBHs, though this cannot be concluded with certainty. To conclude, the client portfolio of CBHs affects the impact of the influence of certain factors.

Employees mindset

In accordance with the interview data, it became apparent that factors related to the mindset of CBH's employees can impact the scalability of the core practices and that its influence can be minimized or improved through education. Employing specialized instructors with expertise in circular practices can have a positive impact and potentially improve or enhance factors such as:

- ⌘ Mindset of the demolition/disassembling workers.
- ⌘ Secondary building components break during transport.

- ⌘ Disassembling buildings can lead to damaged building components.

- ⌘ Motivation to reuse/sell secondary building components (for all CBH employees).

- ⌘ Motivation to streamline the supply processes (for all CBH employees).

- ⌘ Patience to work carefully with secondary building components (for all CBH employees).

Interestingly, from the discussion, it became evident that a potential side effect is that the constraining factor regarding labor force scarcity in the labor market can become less of an issue due to improved labor market opportunities. Since such specialized instructors can appeal to certain employees. It also became clear that CBHs apply different business strategies when it comes to employing and training their employees. As a result, the perceived frequency and influence of certain factors were scored differently. This might explain why the enabling factor

'Motivation to reuse/sell secondary building components (for all CBH employees)' has such scoring differences in average influence and frequency. Also, more interestingly, it indicates that depending on the business strategy and its effects on frequency, this enabling factor can be an important factor to incorporate since it could have a high influence.

Architect Involvement

Insights from the FGD revealed that the involvement of architects early in the process can affect the influence of various factors, as architects often perceive more opportunities for reusing certain building components than clients with a more technical or economical perspective. For example, it can have a positive impact and potentially improve or enhance factors such as:

- ⌘ Older secondary building components do not meet current demands.

- ⌘ Uncertainty as to whether secondary building components will be sold.

- ⌘ Secondary building components are too

specific (lack of knowledge about installations).

- ✘ Lack of standardized sizes for secondary building components.

However, this again largely depends on the clients for the disassembling projects. For example, the participants with clients who were less motivated to reuse secondary building components elaborated that the impact that this involvement has is much smaller.

Interestingly, these factors almost all score high in the impact class. Hence, the early involvement of architects has potentially a large impact on the scalability of the core practices as it can result in higher sales. This is because, potentially, more secondary building components will be reused.

Drive for Reuse

From the FGD it became apparent that meeting sustainability targets is a significant driver for clients to incorporate reuse activities. Hence, providing evidence of the environmental impact (e.g., MPG, CO², NO^x, and PM¹⁰ savings) of reusing the secondary building components can affect clients involvement and sales, subsequently enlarging the effects of certain factors such as:

- ✘ Increase in interest in secondary building components from the (business) market (due to rising costs of new materials and sustainability goals).

Interestingly, the results indicate that this drive has a negative influence on the sales for the CBHs. For example, it was mentioned that the export to foreign countries is made difficult due to this drive. To elaborate, the clients need prove about the processing of the secondary components to meet their sustainability targets. Hence, this drive affects the influence of certain factors such as:

- ✘ Uncertainty as to whether secondary building components will be sold.

Local vs. regional scale

Insights from the FGD revealed the importance of balancing between a broader regional scope, to guarantee a sufficient supply of building compo-

nents, while also avoiding too large distances to minimize transportation costs and CO² emissions. To elaborate, participants discussed the importance of regional balance, suggesting potential regional divisions. According to the participants, a provincial scale level is potentially too small. Instead, a scale that was mentioned as an example is north, south, east, and west.

Enlarging the scale size from which building components derive influences the factor: Supply of secondary building components inconsistency. This factor has a high impact class and can thus be important to improve. However, enlarging the scale will also increase the transportation costs and thus the sales of the components. If the demand for components is not increased first, then enlarging the scale size would not be very effective since other factors will still be in play, such as:

- ✘ Uncertainty as to whether secondary building components will be sold
- ✘ Societal ideas about the pricing of secondary building components.

Subsidies

According to the participants, a lack of subsidies for secondary building components is usually not a constraining factor for CBHs. The reason for this is that clients typically decide whether to purchase new or secondary components before contacting CBHs. This explains why the data was missing and the factor is excluded from the General insights into the influence of the constraining and enabling factors from the previous paragraph. This does not mean that this is not a constraining factor, the influence on the CBHs was just not determined.

According to the participants, the problem is not that the secondary building components are expensive, but the labor costs to make them ready for reuse. This is in accordance with the interview data, that the amount of actions required and associated labor costs play a central role in scalability and is one of the most important factors that influences the supply processes. Implementing subsidies on secondary building components will thus not

suffice. Potential solutions that were mentioned are subsidizing labor costs or taxing CO² emissions.

Interestingly, the constraining factor 'Buyers have to pay double taxes on secondary building components' scored the highest ranking and thus resided in the high-impact class. However, reducing or eliminating this double tax was not specifically mentioned. This might be explained by the fact that due to the low pricing of secondary building components, the total amount of tax is relatively low, but the increased price on top of the labor costs is perceived as a high influence. However, this cannot be concluded with certainty.

Materials Passports

From the FGD it became apparent that materials passports may not be as useful for existing buildings. However, participants expressed approval for such passports for new buildings. Hence, the enabling factor 'Materials passports for buildings', although cored a high impact class, is mostly for future use. Nevertheless, the factor can improve other factors such as:

- ⌘ Too little time for the inventory/Quickscan phase.
- ⌘ (Last minute) changes in the planning for the disassembling and demolition.
- ⌘ Too little time (to store) and space on the disassembling site.
- ⌘ Amount of actions required (or time needed) to prepare secondary building components for market sale.
- ⌘ Lack of knowledge regarding old building components inside the buildings (that are prone to being disassembled).
- ⌘ Lack of knowledge regarding detailed information of secondary building components.

According to the participants, an important difference is that 'building passports' can be understood as two separate things. On one hand, as a data set of all the emissions and product characteristics of the building components insight a building. Hence, to know the embodied CO² emissions and

other factors to calculate environmental impacts. Second, as a (3D) model (e.g. BIM model) that encompasses all the components within a building, including where and how they are attached to the building. The latter is useful for the CBHs, while the first is more useful for their clients. Nonetheless, according to the participants, the issue is not that there is a lack of knowledge about building components within a building or the skills to perform any disassembling processes. This indicates that, although it scores a high impact class and can potentially improve the supply processes, this factor is not as important to directly enhance the core practices and the supply processes.

B2C vs. B2B sales focus

In accordance with the interview data, it became apparent from the FGD that sales focused on Business-to-Consumer (B2C) versus Business-to-Business (B2B) have different impacts on different factors and core practices. For example, it was mentioned that with B2C, more time and effort are required to meet the expectations of these buyer groups. Hence, since the amount of actions and labor costs is a significant factor, the focus on either B2C or B2B has a potentially large influence. An important comment is that all participants of the FGD representing a CBH were primarily already focused on B2B, while participants representing CBHs that are more focused on B2C were not participating. Hence, a more in-depth understanding of the differences was difficult to examine based on only the results from the 'General discussion on the influence of the factors' data, derived from the FGD.

Network and knowledge

In accordance with the interview data, it became apparent from the FGD discussion that the factors:

- ⌘ Establishing a large network in advance regarding diverse potential buyers for various secondary building components.
- ⌘ Knowledge about the specific requirements of secondary building components from potential buyers.

Have a large influence on the scalability of the core practices and supply process. For the first factor, this is also reflected in the scoring, since it scored the highest scoring possible. For the second factor, there was no impact class calculated due to missing data. However, Important aspects that were mentioned is that from experience, the participant elaborated that the demand for building components is rising and these factors are thus also improving, which positively affects the sales. Consequently, in the future, supply consistency and influx will become more important, but as of now, this is sufficient.

Effective Communication

In accordance with the interview data, it became apparent that effective and open communication among all stakeholders involved in supply processes is important for future scalability. This is also reflected by the scoring in the high-impact class. Interestingly, during the discussion, it was mentioned that this factor might become ever more important in the future as different hubs may specialize in specific types of components. This was discussed as a possible strategy in the future to increase scalability. However, participants noted that achieving effective communication can still be challenging.

Emerging policies and guidelines

Insights from the FGD revealed that initiatives for improving policies and guidelines to promote reuse could potentially have a significant impact on the scalability of the supply processes. Examples mentioned include the CB'23 guidelines initiated by Platform CB'23 (CB'23, n.d.) and the innovative idea of paying taxes for CO² emissions. Hence, these are important innovations that are currently being examined by the construction sector.

6.8.1 Conclusion

To conclude, the results from the 'General discussion on the influence of the factors' reveal that the impact of constraining and enabling factors on CBHs depends on various contextual aspects, business strategies, and project-specific influ-

ences such as client's preferences. For example, it revolves around aspects such as client motivations, employee strategies, architect involvement, sustainability goals, regional scale considerations, labor costs, sales focus, network development, and potentially emerging policies and guidelines. These complex interactions emphasize the multifaceted nature of factors influencing the scalability of CBHs and underscore the need for a nuanced approach in addressing their impact on the scalability of the core practices and the supply processes. Additionally, it emphasizes that there is no one-size-fits-all solution and that strategies to enhance enabling factors or limit constraining factors to improve the scalability of the core practice must be tailored to the specific circumstances of the CBHs.

7. DISCUSSION

7.1 Introduction

This chapter discusses the findings presented in Chapter 6. This exploratory research (research aimed to analyze the influence of constraining and enabling factors on the scalability of core practices performed in the supply processes of CBHs. The results indicate that throughout 10 different supply processes, 37 different core practices are performed contributing to the supply of secondary building components for CBHs. Furthermore, in terms of their scalability, these practices are affected by at least 29 constraining and 26 enabling factors that were discovered in this research. Below, the findings regarding the overall supply processes, the constraining and enabling factors, the influence of these factors, some implications of the case study analysis, limitations and recommendations of the results, and the research are discussed.

7.2 Discussion of the findings

This paragraph discusses the findings from this research and elaborates on how they fit with existing research and contribute to our understanding of the supply processes of CBHs. Moreover, it sheds light on the differences between these findings and those proposed in existing literature. Finally, a few practical implications are proposed about the effects on the scalability of the supply processes for CBHs.

Overall supply process of a CBH

In accordance with the findings from empirical data, the overall operational secondary building components supply process (supply processes) for CBHs was re-established, including 'Quickscan' and 'Preparing & Sorting for transportation', in difference to the hypothesis in the introduction which is based on a preliminary literature study. Understanding that all these supply processes (quickscan, inventory, collecting, preparing & sorting for transportation, transporting, inspecting, sorting,

repairing, refurbishing, remanufacturing, preparing, and storing) are involved, helps to gain a more comprehensive understanding of the entire supply process.

The discovery of these additional supply processes that were not previously identified in the literature serves several valuable purposes.

First, clients might be inclined to provide more time or financial incentives for the 'Quickscan' and 'Preparing & Sorting for transportation' when they understand their importance within the entire supply process.

Second, policy interventions supporting these processes can be better targeted towards supporting the individual processes and ultimately enhance the reuse of secondary building components. For example, they could focus on stimulating earlier implementation of the 'Quickscan' process, making it easier for CBHs to identify reusable components. Simultaneously, they could invest in transportation solutions to ensure these components reach their intended destinations without delays or damages.

Finally, a more comprehensive understanding of the entire supply process establishes a new basis for further research. For example, researchers can build upon this knowledge to delve deeper into specific aspects of the supply processes, identify areas for improvement, and develop innovative solutions. Hence, it provides clarity regarding the involvement of all the supply processes related to CBHs. This comprehensive understanding decreases any uncertainties and misconceptions that might have arisen from the initial hypotheses based on the previous literature.

Core practices

Examining and establishing the core practices-as-entities (core practices) revealed some interesting insights within this research. It provided a new and more in-depth perspective on constraining and enabling factors which are discussed in the next paragraph. However, although every supply process is potentially unique and the performance of the embedded core practices may depend on project-specific aspects such as available space,

type of building components, business strategy, demands of the client, and other aspects, the insight in the core practices serves several implications beyond this research.

First, these insights serve as a blueprint for the supply processes of CBHs within the construction sector. They outline the fundamental processes and activities required for the supply processes. Understanding these core practices can help CBHs, but also other stakeholders involved, adapt to more efficient and sustainable practices by applying targeted strategies on specific core practices. Potentially, leading to more effective strategies for promoting the supply processes and ultimately the reuse of secondary building components. To elaborate, the findings and establishment of the core practices reveal the importance of the materials involved in these practices, which include the physical objects, infrastructures, and technologies used in performing them. Understanding and having an overview of the material arrangements involved in the supply processes can lead to a better understanding of the practical and technical considerations that (positively) influence the core practices. One example derived from the results is the smaller transport-racks that allow for easier sorting, inspecting, and storing.

Second, it can help communicate the practices effectively and can thus bring a better understanding between CBHs, clients, and other stakeholders. Potentially enhancing the effectiveness in managing and collaboration, leading to more efficient practices and processes. Finally, from a research perspective, the identification and establishment of these core practices contribute to the body of knowledge in the field of circular construction research. Researchers can use this understanding as a basis for further investigations, comparative studies, and the development of best practices within the circular economy concept.

7.2.1 Constraining and enabling factors

This research identified matching, deviating, and newly discovered constraining and enabling factors in comparison with those identified from the literature. In most cases, the findings correspond with the factors found in the literature presented in

Chapter 2. However, a few findings do not support, vary, or enrich the findings from existing literature. Other factors that have been discovered in this research were not previously identified in the existing literature. All of these factors are described below.

First, the matching factors with the examined literature are presented in a table. Second, the factors that deviate from the examined literature are described. Finally, the factors that enrich the examined literature are presented in a table. This paragraph is divided between constraining and enabling factors.

Constraining factors

Matching constraining factors with examined literature

On the next page in Tabel 7-4 on page 104, the found constraining factors that correspond with factors found in existing literature (presented in Chapter 2) are presented.

Constraining factors that deviate from the examined literature

First, the literature describes that additional storage costs of secondary building components, including costs for transportation and processing are constraining factors (Rakhshan et al., 2020). The results from this research support this and reveal that inconsistencies in the supply of secondary building components contribute to these factors. As a result, CBHs are often inclined to neglect secondary building components since these higher costs result in uncertainties in selling the components. As such, these factors contribute to limiting the scalability of the supply processes and secondary building component reuse. Adding to this knowledge, a practical strategy many CBHs enforce to reduce such costs is selling the secondary building components directly from the disassembling site and reducing processing activities. The results indicate that all CBHs are (trying to) implement this strategy to enhance component sales and that for some the majority of reusable secondary building components from their projects are directly transported to their buyers. Under-

Constraining factors from literature that were identified and correspond with findings from this research

Disassembling is not considered during the design phase of buildings, resulting in the building components being more difficult to disassemble and more likely to be damaged during the disassembling phase (Rašković et al., 2020). This results in more extensive labor when sorting the secondary building components after these are disassembled (Schut et al., 2015).

It is crucial to know the quality of secondary building components (e.g. quality certifications), but since this wasn't considered in advance, it is difficult to trace back this knowledge (Rakhshan et al., 2020).

Since only a small part of the existing building structures and their building components are being digitized (e.g. with material passports) there is little knowledge about those components for disassembling teams, which slows down the process (Loeber & Snoek, 2020).

Disassembling teams are engaged relatively late in the deconstruction process, resulting in limited time available for the comprehensive inventory and disassembly of the building components (Loeber & Snoek, 2020).

Disassembling (or harvesting) instead of demolition the building components from building structures is more labor-intensive and requires more time (Gorgolewski, 2008).

Existing regulations do not support disassembling processes (Rakhshan et al., 2020).

There are additional storage costs when direct-reuse, reusing without the need for a place to process or store the components, of components is not possible, including transportation and processing costs (Rakhshan et al., 2020).

The absence of a robust market for reusable building components combined with a surplus of available stock is the main obstacle (Gálvez-Martos et al., 2018). This is enhanced by the heterogeneity of the available secondary building components, which in turn hinders the development of a robust market.

There is a lack of supply chain coordination and integration which blocks efficient communication and proper reuse of building components (Hosseini et al., 2015).

In the entire chain of stakeholders, there is often a lack of awareness about the economic and environmental benefits of the reuse of building components (Hart et al., 2019; Hosseini et al., 2015; Rakhshan et al., 2020a), often backed by a conservative way of thinking (Knoth et al., 2022).

Finally, the lack of a well-ingrained reuse market results in a lack of trust in suppliers of reused components.

Finally, secondary building components are hardly cheaper than primary materials. Frequently, the cost of virgin materials is lower than the expenses associated with acquiring secondary materials (Loeber & Snoek, 2020).

Tabel 7-4: Overview of the constraining factors from the literature that were identified and correspond with findings from this research.

standing that many CBHs implement these strategies, can be advantageous to further stimulate the amount of component reuse. Practically, clients could integrate more time and space in their disassembling and construction processes to stimulate direct sales from the disassembling site thus mitigating these constraining factors.

Second, according to Hosseini et al. (2015), lower disposal costs further suppress the probability of storage, since they are inclined to use the

most cost-effective alternative. On the contrary, the results indicate that complete component reuse is the preferred option for the CBHs, while recycling is ultimately employed to minimize waste and practically zero "waste" it disposed of. This might be because complete components reuse can be, depending on various aspects, more profitable, it is better to achieve certain sustainability goals, and the knowledge that is gained from these processes is valuable for optimizing these processes and preparing for future policy regula-

tions. Except for achieving certain sustainability goals, these supportive arguments for storing and reusing secondary building components are mostly based on the perspective of the CBHs, which might indicate the reason why the constraining factor of lower disposal costs has not been found in this research. This suggests that the CBH's motivations and priorities for reuse differ from other stakeholders, such as designers and clients, who may be more influenced by cost-effectiveness when it comes to the disposal of components. Hence, it highlights the importance of considering multiple perspectives in sustainability decisions. Furthermore, understanding that this factor does not necessarily apply to the CBHs, could potentially encourage diverse stakeholders such as designers and clients to earlier involve CBHs to emphasize reuse practices. As such, these factors contribute to enhancing and scaling the supply processes and the reuse of secondary building components. Another explanation could derive from the fact that in the Netherlands, 99% of construction and demolition waste is recovered because of its mature construction and demolition waste practices (Monier et al., 2017). Hence, almost no waste is being disposed of and this constraining factor has already been overcome in the country. Therefore, this factor could differ per (national) context and is (almost) not applicable in the Dutch context.

Third, according to the literature, the lack of skills, experience, and knowledge in the disassembling of buildings is often a large barrier (Rakhshan et al., 2020). However, the results from this research did not find any of these constraining factors. An explanation can be that this research specifically collected data from the perspectives of the CBHs. Since these hubs routinely conduct disassembling projects and thus are experts in the field of disassembling buildings, it might be that these factors have not been encountered. If there is a lack of skills, experience, and knowledge in disassembling buildings in the construction sector, CBHs can potentially play an important role in developing and spreading these competencies. For example, the results indicate that CBHs, due to their focus on financial profitability on component reuse, have particularly valuable knowledge on how to perform these activities effectively and efficiently. Under-

standing and acknowledging that the CBHs possess these values competencies, and as such actively involving them in disassembling projects, can enhance the reuse of secondary building components.

Fourth, according to Crielaard (2015, p.24), streamlining the process of smart disassembling by a so-called 'chain director' can guarantee the building owner the highest quality processing of secondary building components which can also stimulate reusing processes. The results from this research indicate that such streamlining is sometimes implemented by the clients by means of conducting an inventory, often executed by expert consultants, before the involvement of the CBH. However, from the perspective of the CBHs, this often leads to too high or wrong expectations regarding reusable secondary building components. As a result, disassembling teams are forced to disassemble certain building components, which could lead to neglecting other potential reusable building components. Hence, contrary to existing literature, the findings of this research indicate that this can sometimes be a constraining factor rather than an enabling one. Understanding this serves several valuable purposes. First, recognizing that conducting a pre-inventory, before the involvement of the CBHs, which can set high or unrealistic expectations for reusable components, is crucial. This information can guide clients in managing their expectations regarding the availability of secondary building components. Second, collaboration between clients, CBHs, and expert consultants can benefit from this understanding. It can encourage open communication about expectations and potential challenges, leading to more effective and collaborative disassembling projects. Finally, it needs to be noted that this research does not suggest that streamlining the process of smart disassembling by a so-called 'chain director' cannot guarantee the building owner the highest quality processing of secondary building components. This enabling factor was just not identified in the empirical data of this research.

Constraining factors that enrich examined literature

On the next page in Tabel 7-5 on page 107,

the found constraining factors that have been discovered in this research, that were not previously identified in existing literature, are presented. The table includes a possible explanation regarding why these factors were not identified. For most factors, the specific and narrow focus of this research regarding the supply processes of CBHs might explain why the factors were not identified. Particularly, since the specific context that these CBHs operate in and their day-to-day operations have not been extensively examined in existing literature. The discovery of these additional constraining factors that were not previously identified in the literature serves several valuable purposes.

First, it provides a more comprehensive understanding of the challenges faced by the construction sector, revealing previously overlooked factors.

Second, it can contribute to the development of the reuse market for secondary building components by addressing these constraining factors, potentially leading to more effective strategies for promoting the supply processes and ultimately the reuse of secondary building components.

Finally, from a research perspective, these identified factors contribute to the body of knowledge regarding their effects on the mechanisms of CBHs and their supply processes. This emphasizes

Constraining factors	
Findings from this research that were not identified within the existing literature.	Possible explanation for why these factors were not identified in this research.
Organizational	
(Last minute) changes in the planning for the disassembling and demolition.	Because it is specific to the CBH's context and day-to-day operations.
Secondary building components break during transport.	Because it is specific to the CBH's context and day-to-day operations.
Too little time (to store) and space on the disassembling site.	Because it is specific to the CBH's context and day-to-day operations. However, additional storage, transportation, and processing costs were identified in the literature (Rakhshan et al., 2020). As such, storing on the disassembling site is a strategy implemented due to these factors.
Lack of space at the CBH (due to high costs).	Because it is specific to the CBH's context and day-to-day operations.
Too high or wrong expectations regarding reusable secondary building components due to pre-inventory.	Because it is specific to the CBH's context and day-to-day operations.
Social	
Mindset of the demolition/disassembling workers.	Because it is specific to the CBH's context and day-to-day operations.
Older secondary building components do not meet current demands.	This factor was specifically mentioned concerning more technologically and interior related products. Hence, these are not specifically reused building components such as beams, doors, steel, etc. This might explain why this factor was not identified in the literature since only literature concerning reused building components was examined.
Societal ideas about the quality of secondary building components.	Although this factor specifically has not been identified in the literature, the lack of a well-ingrained reuse market which results in a lack of trust in suppliers of reused components (Rakhshan et al., 2020), was identified. Arguably, these societal notions are closely intertwined with the absence of trust.

Economic	
Uncertainty as to whether the (disassembling) project will be awarded.	Because it is specific to the CBH's context and day-to-day operations.
Labor force scarcity in the labor market	Because it is specific to the CBH context and day-to-day operations, but also a temporary problem across multiple sectors in the current economic climate.
Demand for custom-made building components by the construction sector.	Because the literature review was only focused on factors within the scope of this research which did not include design processes.
Too large quantities of specific building components coming from large disassembling projects.	Because it is specific to the CBH's context and day-to-day operations. Moreover, this factor might be intertwined with the lack of a well-ingrained reuse market (Rakhshan et al., 2020). As a result of this absence, larger quantities of specific components are difficult to sell for the CBHs.
Regulatory	
Certification of employees and buyers (e.g., safety).	Because it is specific to the CBH's context and day-to-day operations (due to the employment of people at a distance from the labor market).

Tabel 7-5: Overview of the constraining factors from this research that were not identified within the existing literature. Including a possible explanation for why these factors were not identified in this research.

the importance of exploring specific contexts and day-to-day operations of these supply processes in future research.

Enabling factors

Enabling factors that enrich examined literature

On the next page in Tabel 7-6 on page 108, the found enabling factors that correspond with factors found in existing literature (presented in Chapter 2) are presented.

Enabling factors that deviate from the examined literature

First, according to the literature, the available information regarding the 'characteristics, details, certificates and drawings of the recovered building components' can positively influence the reuse of secondary building components (Rakhshan et al., 2020, p. 360). Moreover, according to Rakhshan et al. (2020), involving the manufacturers can stimulate this information sharing since they possess a distinctive advantage regarding the structure, durability, and other characteristics of building compo-

nents. However, the results from this research did not find any collaboration between manufacturers and CBHs. An explanation can be that usually, most buildings that are disassembled are relatively old. For example, Pomponi en Moncaster (2017) found that in northern hemisphere countries, buildings have an average lifespan of at least 60-90 years. Moreover, there is often a lack of detailed knowledge about those components within buildings (Loeber & Snoek, 2020). Hence, this makes it difficult to involve manufacturers before the actual disassembling is conducted. Finally, it needs to be noted that this research does not suggest that involving the manufacturers cannot stimulate the reuse processes of secondary building components. This enabling factor was just not identified in the empirical data of this research. However, this might indicate that the extent to which this factor can be applied might be limited.

Second, according to Rakhshan et al. (2020), accurate separation of the secondary building components after these are disassembled can simulate the reuse of these components, which is backed by the results from this research. Additionally, this research found that smaller transport-racks

Enabling factors from literature
The reuse of building components can be stimulated via the disassembling of the building and its components, instead of demolishing, which can improve the reusability of the building components (Rakhshan et al., 2020a)
Disassembling processes are encouraged by the availability of regulatory and financial incentives, and by the existence of regulations supporting these interventions (Rakhshan et al., 2020a).
Visualization tools that stimulate selective demolition both in planning and also to <i>'allow one to foster demolition practices according to the waste management priorities'</i> stimulate the disassembling of the building (Rašković et al., 2020, p. 926).
Performing a desk study or preliminary (historical) research to draw <i>'as much relevant information as possible from available documentations about the building itself and notable activities that took place during the service life of the building'</i> can stimulate the disassembling of the building (Rašković et al., 2020, p. 925).
A site visit or field survey (inventory) <i>'intended as a general analysis of the actual constitution of the building'</i> stimulates the disassembling processes (Rašković et al., 2020, p. 925)
Providing enough time (e.g. provided by the client) for the disassembling team to conduct the inventory, disassembling, and other practices is important (Loeber & Snoek, 2020).
Accurate separation of the components after these disassembling processes stimulates the reuse of these building components. Therefore, <i>'training operators for effective deconstruction'</i> and separation and the availability of space for storage are factors that enhance reusability (Rakhshan et al., 2020, p. 359).
The available information regarding the <i>'characteristics, details, certificates and drawings of the recovered building components'</i> can positively influence the reuse of these components (Rakhshan et al., 2020, p. 360).
The implementation of quality certifications and manufacturer guarantees for used building components could encourage the growth of reuse (Rakhshan et al., 2020a).
Regulations supporting product reuse, coupled with financial and regulatory incentives to promote deconstruction, can foster greater adoption of reuse practices (Rakhshan et al., 2020a).

Tabel 7-6: Overview of the enabling factors from the literature that were identified and correspond with findings from this research.

(transportation tools such as stacking racks and boxes) and specifically 'bokken' can enhance and improve this separation process while also stimulating other processes in the supply processes. Similarly, the literature states that the availability of space for storage can enhance reusability (Rakhshan et al., 2020). However, the findings of this research go further by specifying that more space at the disassembling site can significantly improve the effectiveness of the supply processes and, consequently, promote the reuse of secondary building components. Hence, the discovery of these additional and more in-depth enabling factors

that were not previously identified in the literature serves several valuable purposes. It provides a more comprehensive understanding of the enabling factors and strategies that can be implemented by CBHs and other stakeholders within the construction sector. Also, they provide practical insights that can benefit CBHs and other stakeholders within the construction sector by optimizing supply processes and enhancing the reuse of secondary building components.

Third, according to the literature, integrating reuse in the design process of new projects can increase the reuse rates since it makes disassem-

bling processes easier (Rakhshan et al., 2020). Additionally, this research found that earlier involvement of CBHs in the construction process is an enabling factor. Hence, this research reinforces the notion from the literature but also identifies a possible valuable stakeholder (the CBH) to be involved in these design processes. For example, their extensive knowledge and experience in demolition are invaluable when considering disassembling in the design phase.

Understanding this serves several valuable purposes. First, recognizing that the CBH potentially have valuable knowledge can stimulate clients and architect to involve them in the design process. Second, from a research perspective, identifying their knowledge emphasizes the importance of exploring their perspectives in future research.

Enabling factors that enrich examined literature

On the next page in Tabel 7-7 on page 110, the found enabling factors that have been discovered in this research, that were not previously identified in existing literature, are presented. The table includes a possible explanation regarding why these factors were not identified. For most factors, the specific and narrow focus of this research regarding the supply processes of CBHs might explain why the factors were not identified. Particularly, since the specific context that these CBHs operate in and their day-to-day operations have not been extensively examined in existing literature. The discovery of these additional enabling factors that were not previously identified in the literature serves several valuable purposes.

First, it provides a more comprehensive understanding of the potential strategies that the construction sector can implement. Second, it can contribute to the development of the reuse market for secondary building components by stimulating these factors, potentially leading to more effective strategies for promoting the supply processes and ultimately the reuse of secondary building components. Finally, from a research perspective, these identified factors contribute to the body of knowledge regarding their effects on the mechanisms of CBHs and their supply processes. This

emphasizes the importance of exploring specific contexts and day-to-day operations of these supply processes in future research.

7.2.2 Influence of the factors

The results from this research provide a general overview of the influence of the examined constraining and enabling factors on the scalability of the supply processes. However, the findings from the focus group discussion (FGD) emphasize the need for a nuanced interpretation of these influences. For example, it was discussed that the client's role, specifically their drive to reuse secondary building components, is an important factor to incorporate when interpreting the results. Nonetheless, these findings provide a more in-depth insight into the influence of these factors. Hence, these finding that were not previously identified in the literature serves several valuable purposes. First, it provides a more comprehensive understanding of the constraining and enabling factors that are involved in the supply processes of CBHs. Second, understanding that factors have different influences can help CBHs, but also other stakeholders involved, adapt to more efficient and sustainable practices by applying targeted strategies to reduce or enhance specific factors that have a large influence. Potentially, leading to more effective strategies for promoting the supply processes and ultimately the reuse of secondary building components. Finally, from a research perspective, the identification and establishment of these more nuanced insights into the influences of the factors, contribute to the body of knowledge in the field of circular construction research. Researchers can use this understanding as a basis for further research, and the development of effective strategies or policies.

7.2.3 Quadrant for research

The results indicate a distinction in business strategy and the performance of (core) practices in relation to the focus on Business-to-Business sales (B2B) or Business-to-Consumer sales (B2C). For example, there are indications that these distinctions lead to organizing digital marketplace activities privately (for B2C), or externally via the Stichting Insert foundations (for B2B). Moreover, the results indicate that practices performed at the CBH's

Enabling factors	
Findings from this research that were not identified within the existing literature.	Possible explaining why these factors were not identified in this research.
Organizational	
Forklift (truck) (alternatively a lifting crane)	Because it is specific to the CBH's context and day-to-day operations.
Having a recycling option as a backup for recycling leftover building components.	Because it is specific to the CBH's context and day-to-day operations.
Network of standard buyers for specific secondary building components that they can also dismantle themselves (collaborations).	Because it is specific to the CBH's context and day-to-day operations.
The 'Reuse motivation bringer'.	Although this factor was not specifically identified, (generally) training operators for effective disassembling and separation was found (Rakhshan et al., 2020). It can be argued that these factors can be included as a sub-category.
Employing workers at a distance from the labor market to reduce labor costs.	Because it is specific to the CBH's context and day-to-day operations.
Establishing a large network in advance regarding diverse potential buyers for various secondary building components.	Because it is specific to the CBH's context and day-to-day operations.
Knowledge about which secondary building components are profitable to sell.	Because it is specific to the CBH's context and day-to-day operations.
Knowledge about the specific requirements of secondary building components from potential buyers.	Because it is specific to the CBH's context and day-to-day operations.
Social	
Motivation to reuse/sell secondary building components (for all CBH employees).	Although this factor was not specifically identified, (generally) training operators for effective disassembling and separation was found (Rakhshan et al., 2020). It can be argued that this factor can be included as a sub-category.
Motivation to streamline the supply processes (for all CBH employees).	Although this factor was not specifically identified, (generally) training operators for effective disassembling and separation was found (Rakhshan et al., 2020). It can be argued that this factor can be included as a sub-category.
Patience to work carefully with secondary building components (for all CBH employees).	Although this factor was not specifically identified, (generally) training operators for effective disassembling and separation was found (Rakhshan et al., 2020). It can be argued that this factor can be included as a sub-category.
Economic	
Effective and open communication among all stakeholders connected to the supply processes.	Because it is specific to the CBH's context and day-to-day operations.
Directing the sale of secondary building components towards both business and private customers, but primarily focusing on one.	Because it is specific to the CBH's context and day-to-day operations.

Tabel 7-7: Overview of the enabling factors from this research that were not identified within the existing literature. Including a possible explanation for why these factors were not identified in this research.

location change and increase in the B2C context due to the importance of secondary building components presentation to these customers. For example, components are more frequently removed from transport transport-racks (carts, racks, crates) and neatly laid out at the hub. Additionally, they are often more extensively registered and photographed. In contrast, in the B2B context, they are sometimes simply placed in a rack and sold in large quantities, potentially even from the disassembling site directly, to buyers.

A similar distinction in business strategy and the performance of certain activities is indicated within the differences when comparing the acquisition of secondary building components from external sources, versus those generated internally within a project.

For example, the results indicate that receiving building components from external sources requires more extensive separating, due to higher counts of damaged components. Moreover, the income from this source tends to be less predictable. However, the potential influx is larger since they can derive from more sources. Conversely, generating these components internally can streamline the separating process starting at the disassembling site while

simultaneously, employees can be trained to perform practices that minimize damage to the secondary building components. It is speculated that these distinctions have a large impact on the scalability of both the reuse market generally as well as for the supply processes of the hubs. Consequently, these two distinctions have been visualized on a quadrant (See Figure 7-1 on page 111). It is important to know that the quadrant shows the locations of the four case studies indicative

Impact on scalability

Literature indicates that the

absence of a robust market for these reusable building components combined with a surplus of available stock is a large obstacle (Gálvez-Martos et al., 2018). Hence, to enhance scalability and create a stable secondary building component market, a large and stable influx of components is important. As such, the Stichting Insert Foundation, and specifically Insert Marktplaats, is an example of an initiative that aims to enhance this (Insert.nl, n.d.). This initiative specifically focuses on national collaboration via combining sources thereby creating scale and stability. An important aspect that was also discussed in the FGD. However, there are minor indications from the findings of this research that B2C results in more regional components sales via privately organized marketplaces: *“We looked at that and decided based on experience to set it up ourselves, a marketplace. Because we see that 80% of the materials are not sold further than 15 or 20 kilometers from our hubs. So those market-*

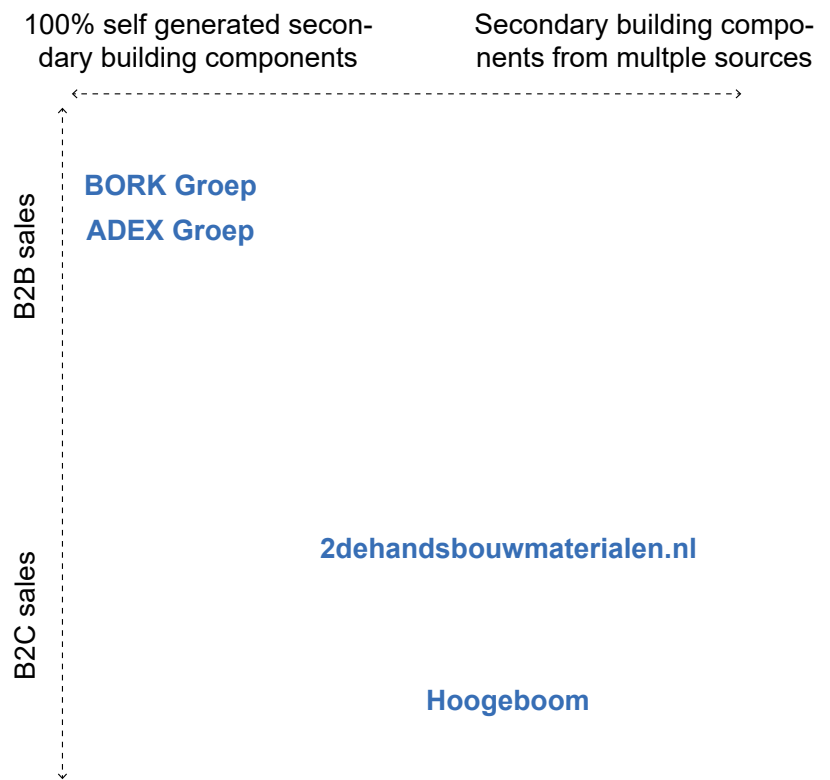


Figure 7-1: Illustrative overview of the theorized quadrant of B2B vs B2C and the acquisition of secondary building components from external sources vs internally. Including inductive the four case studies.

places have a regional effect.” (Interview 6). Thus, a potential result is that if CBHs focus more on B2C, it can have a negative impact on collaborative initiatives and therefore block the establishment of a stable reuse market for the construction sector and perhaps the scalability of the CBHs.

Similarly, to create scale, a large influx of building components is important. Hence, combining sources would be better in terms of the amount of components. However, when CBHs focus on B2C, the robustness of this influx is potentially more unpredictable, while also a potential increase in the price of the components due to additional labor costs. Hence, this can decrease the attractiveness of reusing secondary building components for the construction sector, also due to competing prices for new building components. However, the results from the FGD indicate that sustainability targets are a significant driver for clients to incorporate reuse activities. Thus, perhaps making this argument about pricing less relevant, specifically considering the findings regarding the increasing interest in secondary building components due to rising sustainability goals.

To conclude, the indication regarding the quadrant including B2B vs. B2C and the acquisition of secondary building components from external sources vs. internally, reveal some potentially important nuances and phenomena. However, more in-depth research is needed to establish a better understanding of the quadrant and the influences it poses.

7.3 Limitations

This paragraph discusses the limitations of this research and elaborates what their potential impact on the results of this research. Hence, below, the limitations are divided into limitations from the theoretical lens and the conceptual framework, overall research design, and used methods for data collection.

7.3.1 Limitations from the theoretical lens and the conceptual framework

First, social practice theory emphasizes the interconnectedness between practices. As such, this

research also focused on the connection between practices both embedded within and directly outside the operational supply processes. However, the complexity of where, when, and how practices were connected made it challenging to analyze and interpret the relationships between them. For example, it was difficult to determine when practices were not directly connected, since all practices examined were enacted due to the CBH’s motivation to reuse secondary building components. Hence, the connection between practices, or the lack of them, might have been made with a more subjective nature than reality.

Second, the limited criteria that were defined to determine whether a practice was directly linked to practices within the supply processes potentially influenced the results. To elaborate, it was difficult to determine whether a practice was or was not ‘directly linked’ to the supply processes, and in some cases, this was based on personal interpretations. Therefore, due to limited criteria, the certainty to determine whether all (core) practices have been included is limited.

7.3.2 limitations of the research design

First, according to Shove et al. (2012), a practice-as-entity is a distinguishable and relatively stable concept such as driving and cooking. It is a combined entity of all different performances of a recognizable pattern of actions (Svennevik, 2022). Stronger practices-as-entities are created through the observation of many recurrent performances with a similar nature. The more performances are observed and integrated, the stronger and more distinct the practices-as-entities become. However, for this research, practices-as-entities were defined by extrapolating all the observed practices-as-performances of each case study and combining those with a similar nature. In practice, this resulted in practices-as-entities that were defined as such based on a small number of observed practices-as-performances. Potentially, this raises questions about the robustness of these defined entities, as they may not have been observed as frequently as those defined based on more data points. This does not mean that the research is invalid, but it acknowledges potential limitations. Hence, it is therefore recommended that future research or

methodological improvements could be made to identify possibly other stronger practices-as-entities and results.

Second, due to the wide focus of this research, and the extensive range of diverse practices that emerged from this lens, in combination with the limited time available, the practices were only analyzed on a superficial level. This could be a limitation as it might have prevented exposure to more detailed insights that could have been valuable.

Third, a limitation of this research design is the diversity of the case studies. The case studies have been selected based on the hypothesized concept of the CBH and the supply processes which were validated by the data gathered from the empirical data collection. Moreover, extra criteria were outlined to further ensure the compatibility and enrichment of the data. However, due to the limited availability of literature data reading CBHs, the case studies were limited in terms of their diversity. This became apparent during the FGD. To elaborate, when discussing the client portfolio of Stichting Insert in comparison with the portfolios of the case studies for this research, it became noticeable that the influence of certain factors is affected by the client's CBHs serve. Since the case studies and thus the CBHs in this research are all historically derived from a demolition company, the diversity of examined constraining and enabling factors is potentially limited due to their similar clients portfolios and historical backgrounds.

Finally, adding to this, such contextual boundaries potentially shape the nature and performances of practices. To elaborate, this became apparent from the constraining factor the 'Mindset of the demolition/disassembling workers'. Because the disassembly team members the CBH employs are the same people as the former demolishing workers, this factor was involved in all case studies. Hence, the (historical) background of the case studies resulted in this, and potentially other factors as well. In return, such factors also motivated certain practices. For example, the practice 'Motivate, enthuse, and guide the disassembly team'. To conclude, the findings of this study based on certain case studies, make it possible that these are not universally applicable. Hence, it is recom-

mended that more case studies with a different (historical) background are examined to identify possibly other practices, constraining and enabling factors.

7.3.3 limitations from the methods for data collection

First, many semi-structured interviews primarily involved foremen, supervisors, and individuals in leadership or managerial roles responsible for supply processes. These individuals were intentionally selected following orientation meetings and exploratory interviews. However, since many of the actual recorded practices, such as inspecting, removing nails, and disassembling building components, were not directly performed by these individuals, at least not at the time of recording, possibly, the true meanings and competences elements have been left out. To conclude, the lack of verification via interviews with practitioners of the examined practices reduces the validity and reliability of the indicated elements of these practices and requires addressing in follow-up studies.

Second, the results of this research might have been influenced by an uneven distribution of actors in the Semi-structured interviews. For example, three interviewees from the first case study (ADEX Groep) are counted in the data, while only one interview was conducted for case studies 3 and 4. Hence, in contrast, the latter two were under-represented. As a potential result, the practices conducted at the ADEX case study may be much more enriched, and potentially more practices have been examined. In contrast, the performances or motivations of certain practices driven by for example the business strategy of case studies 3 and 4, might have been overlooked. Hence, this research is limited in its certainty that all practices for each case study are accounted for and thus might have missed important business-driven factors. To conclude, the lack of enrichment of the data via other interviews for case studies 3 and 4 reduces the validity and reliability of the examined practices and the motivations behind them and requires addressing in follow-up studies.

Third, the limited number of participants in the semi-structured interviews, as well as the limited

amount of observations per case study, might have resulted in missed observed practices, although validity was enhanced through the creation of a structured interview protocol beforehand, which was based on the pre-established supply processes. Nonetheless, to increase the research validity, a larger sample size from each case study would have been desired. To elaborate, the core practices have been translated and included based on the performances of practices that were discovered in each case study. Hence, possibly, some practices have been marked as not being performed at certain CBHs and were thus not taken into account as core practices. Therefore, due to limited data availability, the certainty to determine whether all core practices have been included is limited.

Fourth, in regards to the observations, there is a risk when observing a staged performance that important aspects of the daily work routine of the practitioner could have been intentionally or unintentionally omitted, or irrelevant aspects might have been noted. In literature, this is known as observer interference. This could have happened because respondents might have felt uncomfortable with the actual performance or potentially exaggerated the activities involved. As a result, the true performances of practices might have been overlooked. Especially since the observations were only conducted once per case study, this research is limited in its certainty that observations were authentic.

Finally, due to the limited amount of participants at the FGD, as well as the absence of the two CBHs that differentiate from the CBHs that participated, in terms of their business strategy (B2B vs. B2C), the nuances about the influences that derived from the general discussion are possibly limited. For example, it became noticeable that the influence of certain factors is affected by the client's CBHs serve. However, since the two case studies have a primary focus on the B2C, their input and nuances regarding such clients were missed. However, these case studies did provide data regarding the scoring table: Frequency and influence'. Nonetheless, due to limited data availability, the certainty and nuances regarding the influences of factors are limited.

To conclude, this research has its limitations

that derived from the theoretical lens and the conceptual framework, the research design, and the methods for data collection. Nonetheless, the results of this research are still valid for answering the research questions as well as providing a more in-depth understanding of the supply processes, practices performed and constraining and enabling factors involved in the concept of CBHs. As such, it represents a solid foundation for further research.

7.4 Personal Reflection

In this chapter, I would like to reflect personally on my thesis journey, which I have been experiencing over the last 7 months. Starting in February, I tactically chose my topic quickly since I knew I had weaknesses in choosing. As mentioned in the preface of this thesis, the topic stems from my personal interest in improving how our society consumes resources through the reuse of secondary building components. Additionally, although I had virtually no prior knowledge about it when I started, I first heard about social practice theory from classmates during the first year of my MADE study. I was intrigued by the overall approach of the theory. Moreover, I wanted to embark on something innovative, and I got the impression from my first supervisor, Mart, who was enthusiastic about my ideas by the way, that both this topic and applying this theory to it were groundbreaking. Hence, without much further thought, I decided then and there in the first weeks of my thesis journey to go for it.

As a practical, hardworking person who sometimes likes to philosophize (too much) about the small things in life, and having climbed my academic ladder starting from secondary vocational education without much academic experience, I soon realized I had two major disadvantages in quickly and decisively completing this report: 1) I had very little experience with academic work, aside from some small assignments in the first year of MADE. 2) I sometimes overthink things too much and wrongly focus on details, especially when dealing with very theoretically driven ideas and approaches. However, as I finish this thesis, I can confidently state that this thesis journey has significantly strengthened these two aspects! These are

the two most valuable lessons I have learned over the past months.

Deciding on the final topic

At the beginning of this thesis period, while examining the initial literature, it was challenging to find any scientific literature on circular building hubs because there was almost nothing available. Therefore, it was also challenging to identify a specific knowledge gap because it seemed that there was a massive gap in knowledge for almost the entire concept. This was particularly difficult because I could not easily connect to previous research. This resulted in much overthinking and rethinking in the first few weeks about what I wanted to research. One thing I learned later though is that 'academic literature' and 'real life' have sometimes different vocabulary.

Understanding Social Practice Theory

In the first few weeks, it was quite difficult to grasp exactly what social practice theory was and how it would help me with my research. I spoke to various educators from both Wageningen and Delft universities, who sometimes also mentioned that it might not be the easiest theory to start with, especially for someone with practically zero experience in academic work (which was not very motivating). The fact that academia utilizes this theory in many different approaches, although I cannot truly say if this isn't always the case for such theories, didn't make it easier to find a good example. However, due to my tendency to overthink and philosophize, with some delay and help from Irina and Mart, I got a reasonably good idea of how to look at things through the social practice lens. Hence, although I acknowledge that I might not have used it most effectively, I have become very fond of the theory and how it can help us perceive the world around us. I can definitely recommend this lens to others.

Consent form, Data management plan, and HREC approval

Looking back, the most annoying (yet important!) part of this entire thesis process was obtaining the required HREC (Human Research Ethics Committee) approval. For my fellow MADE students: "HREC application should be submitted

for every research study that involves human participants (as Research Subjects) carried out by TU Delft researchers". I had no prior experience in conducting research, which made dealing with the administrative aspects even more daunting. Understanding all the requirements, knowing what to include in the application, and creating the data management plan consumed a significant amount of time and energy. What did not help was that many of my fellow MADE students never even heard of this approval.... However, in hindsight, I also believe that my attitude towards the approval process was draining my energy. Something to keep in mind next time. Looking back though, I'm grateful for the opportunity to have learned about these administrative procedures, despite the initial challenges.

Finding interviewees and participants for data collection

Due to some initial delay in my thesis, I ended up finding companies and people for my data collection during the beginning of the summer. This was especially challenging for the Focus Group Discussion. One free tip: Don't try to (systematically) collect empirical data from people in the Dutch construction sector in the months of July and August. As a result, I had to delay the focus group session until the end. Unfortunately, even then, organizing it turned out to be challenging, and ultimately, only three participants joined. I think it could have been useful to redo it or at least organize another one. Also, because the focus group could have been more effective. However, at the same time, I feel like I really did my best, and a few interesting results have been discovered.

Analyzing the data

One thing I definitely learned from this thesis is the time it takes to precisely transcribe interview recordings into text. Although basic AI-driven programs massively helped, I hope for our future students that these innovations will continue to improve. Looking back on my period, I think those weeks were the most challenging in terms of finding motivation. Aside from these weeks though, I have experienced this thesis mostly as a fun learning experience.

Although utilizing the lens of SPT to examine the practices embedded within the supply processes was useful since I could use it to guide the interviews and the data analysis, it was sometimes also overwhelming. Especially when I tried to focus on identifying specific practices and trying to allocate all the elements among them. This resulted in time-consuming analysis phases with sometimes still unclear outcomes since not all practices were extensively elaborated.

The researcher's pen

As stated above, starting with this thesis, I had very little experience with academic work. As a result, I spent many hours reading materials available from the universities, Scribbr (many thanks to them), Google Scholar, YouTube, and numerous other websites to learn about all the different sections that an academic study must entail. It took quite some time to understand how certain parts needed to be written, which aspects needed to be addressed, and why they were important. Unfortunately, or luckily, I seemed to grasp most concepts I used only towards the end of my thesis. As a supplement to the preface, I want to once again thank Mart, my first supervisor, for taking the time to guide me throughout this process.

Things to improve next time/tips

- ✂ Don't wait to proceed with the work if the theory isn't fully understood yet; there will always be more to wrap your head around.
- ✂ Try to mostly understand the methods you are using and comprehend all the (dis)advantages before executing them.
- ✂ Avoid juggling two jobs and writing a full-time thesis simultaneously.
- ✂ Stay in contact with fellow thesis convicts; this will make the journey a little less all-by-myself.
- ✂ Don't try to do something ground-breaking if you don't even get the basics.
- ✂ Try to keep it short.
- ✂ Doing research can be very creative work and much fun!

8. CONCLUSION

The construction industry's significant consumption of materials, CO² emissions, and construction and demolition waste stresses the need for change. Reusing secondary building components via circular building hubs (CBHs) emerges as a potential solution to reduce these environmental impacts.

Therefore, this exploratory research (research) aimed to identify the extent to which constraining and enabling factors influence the scalability of core practices embedded in the operational secondary building component supply processes (supply processes) of these CBHs. As such, it aimed at contributing to a new understanding of the effects of these factors and thereby contribute to the development and scaling up of these processes. Hence, the main research question was as follows: 'What are core practices embedded within the secondary supply processes for circular building hubs, and to what extent are involved constraining and enabling factors influencing the scalability of these practices?'

Through a qualitative case study research approach, centered around a conceptual framework based upon a Social Practice Theory (SPT) perspective and hypothesized supply processes for CBHs, this study concluded that throughout 10 different supply processes, 37 different core practices are performed that contribute to the supply of secondary building components for CBHs. Furthermore, based on semi-structured interviews and an SPT-driven analysis approach, the research revealed that these core practices are affected by at least 29 constraining and 26 enabling factors. Also, the analysis within this research shows how social practice approaches can give more context-sensitive insights and reveal in-depth knowledge regarding involved factors that shape the performance of practices. Taking inspiration from Pomponi & Moncaster (2017), Densley Tingley et al. (2017), and Rakhshan et al. (2020), both the constraining and enabling factors were divided into the following categories: organizational, social, economic, regulatory, and technical.

The extent to which these factors influence the core practices is for this research divided into low, medium, and high impact classes. The impact class for each factor was based on quantitative data derived from experts involved in the supply processes of CBHs. As such, for the constraining factors, 1 fell under the category of low impact, 16 under the category medium impact, 11 under the category of high impact, and for one factor there was insufficient data. For the enabling factors, zero fell under the category low impact, 6 under the category medium impact, 18 under the category high impact, and for two factors there was insufficient data.

An in-depth discussion with experts via a Focus group discussion method highlighted that the influence of these constraining and enabling factors is more complex and likewise dependent on various contextual aspects, business strategies, and project-specific influences such as client's preferences. Hence, the complex nature of not only these factors but also other aspects influencing these factors emphasizes that there is no one-size-fits-all solution. Moreover, it highlights that strategies to reduce constraining factors or enhance enabling factors to improve the scalability of the core practices must be tailored to the specific circumstances of CBHs.

To conclude, the results of this research contribute new findings to the existing literature by supporting, enriching, and expanding knowledge regarding constraining and enabling factors. This offers a valuable foundation for further development of targeted strategies to enhance the scalability of the core practices embedded in the supply processes, and thereby ultimately reduce the environmental impact of the construction industry.

8.1 Recommendations

The findings of this research shed new light on the supply processes, embedded core practices, and the influence of constraining and enabling factors on the scalability of these practices. Hence, the findings make several contributions to existing literature. From these findings, various recommendations can be derived for both practical implica-

tions for CBHs and further research. Consequently, this paragraph elaborates on the recommendations that have been established based on the results and discussion of this research.

Recommendations for CBHs

It is recommended that CBHs first focus on various contextual aspects, business strategies, and project-specific influences, before implementing new strategies to scale up their supply processes.

For example, they should ask themselves: 1) Who are my clients, and what are their motivations for reusing secondary building components? 2) Which employee strategies do I want to implement? 3) Where am I located and up to what distances is it still profitable to collect secondary building components? 4) Who are interesting to collaborate with to enhance supply consistency and sales? To elaborate:

1: Understand that clients play an important role in determining the relevance and impact of both constraining and enabling factors. Moreover, recognize that client motivations significantly impact the scalability of core practices and thus the supply processes. Therefore, tailor services to clients' reuse motivations, often driven by sustainability targets for B2B and pricing for B2C. For example, when focusing on B2B, emphasize the environmental benefits of reuse by providing CO₂ emissions savings reports.

2: Labor costs have a very high impact on sales. This can be reduced by focusing on certain strategies such as employing individuals with a distance to the labor market or by reducing the amount of necessary actions required to make secondary building components ready for sale. Either way, recognize the importance of the mindsets of employees and individuals conducting the practices embedded in the supply processes. Consider providing training to foster a positive attitude toward the desired performances of the involved practices based on your business strategy. To enhance such training efforts, recognize that there is a certain self-improving feedback loop due to the interconnectedness between practices performed that provide an iterative learning process in reversed order. Therefore, start training employees at the hub

itself.

3: Recognize the importance of the locations of the CBH and its influence on both transportation costs as well as CO₂ emissions. The latter is also important due to the client's motivation to reuse secondary building components. Hence, try to balance regional focus for minimizing transportation costs and emissions, while also maximizing the supply of secondary building components by enlarging the source area.

4: Reusing secondary building components requires vast amounts of efficient communication and collaboration between many stakeholders. Hence, it is recommended to set up collaborative networks between all stakeholders, enhance information sharing, and improve transparent communication.

For example, collaborate with architects early in projects for their insights into possibilities for reusing specific building components. Gather as much knowledge as possible about buyer requirements to effectively implement supply chain strategies. Or, create alliances with other nearby CBHs to improve influx consistencies of components.

When such aspects are considered, it is recommended that CBHs focus on improving important core practices within the supply process. Create a hierarchy based on their connectedness with other practices and shared elements between them. The analysis from this research offers a valuable demonstration. Therefore CBHs should ask themselves: Which practices are often performed within one fluent sequence (a practice bundle)? Which elements are shared between multiple practices? How can I develop or improve specific elements within these practices to enhance their effectiveness? For example, recognize that the practice 'Identify building component requirements by reaching out to potential buyers' has potentially a large influence on many other practices.

Recommendations for further research

In addition to addressing the research questions of this research, it is intriguing to consider potential future research based on the results.

The findings of this research shed new light on the supply processes of CBHs. During the research, it became apparent that due to their similar background, they all strongly experienced similar constraining factors such as the mindset of the demolition/disassembling workers and their client motivations for hiring them. It is therefore recommended that more CBHs with a different (historical) background are researched to possibly identify new constraining and enabling factors and make nuances to those found in this research.

Due to many factors related to the pricing of the secondary building components, it became apparent that many CBHs apply the strategy of selling their components directly from the disassembling site. This is potentially an interesting strategy to enhance the reuse of secondary building components. Therefore, further research should be conducted as to how component sales directly from the disassembling site can be stimulated. For example, how can policy interventions enhance these practices?

The findings of this research indicate a certain influence from the speculated quadrant in the discussion section, including B2B vs. B2C and the acquisition of secondary building components from external sources vs. internally. More in-depth research is needed to establish a better understanding of the proposed quadrant and the influences it poses.

Overall, these recommendations provide possibilities for further research in the fields of sustainability, circular construction, supply chain management, and policy development within the construction industry.

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10. APPENDIX

Appendix A – Coding within ATLAS.TI

Appendix B – Questions list, Semi-structured interviews

Appendix C – Tables of the practices

Appendix D – Connections between core practices-as-entities

Appendix E - The scoring table: Frequency and influence

Appendix F - Blank consent form

Appendix G - Ethical clearance Committee TUD

Appendix H - Interview transcripts (External).

Appendix I - Focus Group Discussion (External).

Appendix J – Observation field notes & photo's (External)

Appendix A – Coding within ATLAS.TI

- a. Constraining factors (General)
- b. Enabling factors (General)
- c. External process Extern- General
- d. External process Extern - Competences
- e. External process Extern - Material
- f. External process Extern - Meanings
- g. External process Extern - Practice
- h. External process Intern - Material
- i. External process Intern – Meanings
- j. External process Intern – Competences
- k. External process Intern - Practice
- l. Processes
- i. Process: Collecting - Competences
- ii. Process: Collecting - Material
- iii. Process: Collecting - Meanings
- iv. Process: Collecting - Practice
- v. Process: General - Competence
- vi. Process: General - Material
- vii. Process: General - Meanings
- viii. Process: General - Practice
- ix. Process: Inspecting – Competences
- x. Process: Inspecting - Materials
- xi. Process: Inspecting – Meanings
- xii. Process: Inspecting - Practices
- xiii. Process: Inventorize - Competences
- xiv. Process: Inventorize – Meanings
- xv. Process: Inventorize - Materials
- xvi. Process: Inventorize - Practice
- xvii. Process: Packing for transport - Competences
- xviii. Process: Packing for transport - Material
- xix. Process: Packing for transport - Meanings
- xx. Process: Packing for transport - Practice
- xxi. Process: Preparing - Competences
- xxii. Process: Preparing - Material
- xxiii. Process: Preparing – Practice
- xxiv. Process: Preparing - Meanings
- xxv. Process: Remanufacturing – Competences
- xxvi. Process: Remanufacturing - Materials
- xxvii. Process: Remanufacturing - Meanings
- xxviii. Process: Remanufacturing - Practice
- xxix. Process: Repairing – Competences
- xxx. Process: Repairing – Materials
- xxxi. Process: Repairing - Meanings
- xxxii. Process: Repairing - Practice
- xxxiii. Process: Sorting for transport – Competences
- xxxiv. Process: Sorting for transport - Materials
- xxxv. Process: Sorting for transport - Meanings
- xxxvi. Process: Sorting for transport - Practice
- xxxvii. Process: Transporting – Competences
- xxxviii. Process: Transporting - Materials
- xxxix. Process: Transporting - Meanings
- xl. Process: Transporting - Practice

Appendix B – Questions list, Semi-structured interviews

Vragenlijst interviews	
Storing	Vragen
	<ul style="list-style-type: none"> • Wat is uw functie? En wat zijn uw belangrijkste dagelijkse werkzaamheden?
	<ul style="list-style-type: none"> • Wat zijn de belangrijkste aandachtspunten / wat heeft u zoal nodig als het gaat om het opslaan van de bouwmaterialen?
	<ul style="list-style-type: none"> • Waar zitten knelpunten/belemmeringen als het gaat om het opslaan van bouwmaterialen?
Matererials	<ul style="list-style-type: none"> • Waar slaat u de materialen op? • Welke tools en gereedschappen gebruikt u om deze handeling uit te kunnen voeren en de bouwmaterialen op te slaan?
Competen.	<ul style="list-style-type: none"> • Wat zijn belangrijke vaardigheden die bij het opslaan van materialen komen kijken? En welke kennis is handig om te hebben?
Meanings	<ul style="list-style-type: none"> • Wat zijn voor u de belangrijkste drijfveren om de bouwmaterialen op te slaan / om deze methode/ tools toe te passen? • Wat vindt u ervan dat deze materialen op deze manier worden opgeslagen? Kan het anders/efficiënter?
Verdieping	<ul style="list-style-type: none"> • Zijn er ook nog andere manieren om deze handeling uit te voeren en de bouwmaterialen op te slaan?
	<ul style="list-style-type: none"> • Zouden daarbij andere tools ook handig kunnen zijn om deze handelingen uit te voeren? Welke zijn dat dan?
	<ul style="list-style-type: none"> • Vragen andere type bouwmaterialen een andere aanpak of plek om deze op te slaan? Wat voor vaardigheden en tools/gereedschappen zijn daarbij nodig?
	<ul style="list-style-type: none"> • Moeten sommige materialen met meer dan 1 persoon worden behandeld om op te slaan?
	<ul style="list-style-type: none"> • Met wie heeft u veel contact, werkt u veel samen of bent u afhankelijk van bij het uitvoeren uw werkzaamheden? Wat is zijn of haar functie?
Prepairing	
	<ul style="list-style-type: none"> • Wat is uw functie? En wat zijn uw belangrijkste dagelijkse werkzaamheden?
	<ul style="list-style-type: none"> • Wat zijn de belangrijkste aandachtspunten / wat heeft u zoal nodig als het gaat om het voorbereiden van de bouwmaterialen voor opslag, hergebruik en/of transport?
	<ul style="list-style-type: none"> • Waar zitten knelpunten/belemmeringen als het gaat om het voorbereiden van de bouwmaterialen voor opslag, hergebruik en/of transport?
Matererials	<ul style="list-style-type: none"> • Waar gaan de materialen meestal als eerste naar toe? Wat zijn nog andere plekken? • Welke tools en gereedschappen gebruikt u om deze handeling uit te kunnen voeren als het gaat om het voorbereiden van de bouwmaterialen voor opslag, hergebruik en/of transport?
Competen.	<ul style="list-style-type: none"> • Wat zijn belangrijke vaardigheden die bij het voorbereiden van materialen komen kijken? En welke kennis is handig om te hebben?
Meanings	<ul style="list-style-type: none"> • Wat zijn voor u de belangrijkste drijfveren om de bouwmaterialen voor te bereiden / om deze methode/ tools toe te passen? • Wat vindt u ervan dat deze materialen op deze manier worden voorbereid? Kan het anders/efficiënter?
Verdieping	<ul style="list-style-type: none"> • Zijn er ook nog andere manieren om deze handeling uit te voeren en de bouwmaterialen voor te bereiden voor opslag, hergebruik en/of transport?
	<ul style="list-style-type: none"> • Zouden daarbij andere tools ook handig kunnen zijn om deze handelingen uit te voeren? Welke zijn dat dan?
	<ul style="list-style-type: none"> • Vragen andere type bouwmaterialen een andere aanpak of plek om deze voor te bereiden? Wat voor vaardigheden en tools/gereedschappen zijn daarbij nodig?
	<ul style="list-style-type: none"> • Moeten sommige materialen met meer dan 1 persoon worden behandeld om voor te kunnen bereiden?
	<ul style="list-style-type: none"> • Met wie heeft u veel contact, werkt u veel samen of bent u afhankelijk van bij het uitvoeren uw werkzaamheden? Wat is zijn of haar functie?
Repairing+A3 4:B48A34:B4 7	Refurbishing / Remanufacturing
	<ul style="list-style-type: none"> • Wat is uw functie? En wat zijn uw belangrijkste dagelijkse werkzaamheden?

	<ul style="list-style-type: none"> • Wat zijn de belangrijkste aandachtspunten / wat heeft u zoal nodig als het gaat om het repareren, renoveren of herfabriceren van de bouwmaterialen?
	<ul style="list-style-type: none"> • Waar zitten knelpunten/belemmeringen als het gaat om het repareren, renoveren of herfabriceren van bouwmaterialen?
<i>Materials</i>	<ul style="list-style-type: none"> • Waar voert u deze repareren, renoveren of herfabriceren werkzaamheden uit? • Welke tools en gereedschappen gebruikt u om deze handeling uit te kunnen voeren en de bouwmaterialen op te repareren, renoveren of herfabriceren?
<i>Competen.</i>	<ul style="list-style-type: none"> • Wat zijn belangrijke vaardigheden die bij het repareren, renoveren of herfabriceren van materialen komen kijken? En welke kennis is handig om te hebben?
<i>Meanings</i>	<ul style="list-style-type: none"> • Wat zijn voor u de belangrijkste drijfveren om de bouwmaterialen op te repareren, renoveren of herfabriceren / om deze methode/ tools toe te passen? • Wat vind u ervan dat deze materialen op deze manier worden gerepareerd, gerenoveerd of geherfabriceerd? Kan het anders/efficiënter?
<i>Verdieping</i>	<ul style="list-style-type: none"> • Zijn er ook nog andere manieren om deze handeling uit te voeren en de bouwmaterialen op te repareren, renoveren of herfabriceren? • Zouden daarbij andere tools ook handig kunnen zijn om deze handelingen uit te voeren? Welke zijn dat dan? • Vragen andere type bouwmaterialen een andere aanpak qua repareren, renoveren of herfabriceren? Wat voor vaardigheden en tools/gereedschappen zijn daarbij nodig? • Moeten sommige materialen met meer dan 1 persoon worden behandeld om op ze te repareren, renoveren of herfabriceren? • Met wie heeft u veel contact, werkt u veel samen of bent u afhankelijk van bij het uitvoeren uw werkzaamheden? Wat is zijn of haar functie?

Inspecteren	
	<ul style="list-style-type: none"> • Wat is uw functie? En wat zijn uw belangrijkste dagelijkse werkzaamheden?
	<ul style="list-style-type: none"> • Wat zijn de belangrijkste aandachtspunten / wat heeft u zoal nodig als het gaat om het inspecteren van de bouwmaterialen?
	<ul style="list-style-type: none"> • Waar zitten knelpunten/belemmeringen als het gaat om het inspecteren van bouwmaterialen?
<i>Materials</i>	<ul style="list-style-type: none"> • Waar inspecteert u de materialen? • Welke tools en gereedschappen gebruikt u om deze handeling uit te kunnen voeren en de bouwmaterialen te inspecteren?
<i>Competen.</i>	<ul style="list-style-type: none"> • Wat zijn belangrijke vaardigheden die bij het inspecteren van materialen komen kijken? En welke kennis is handig om te hebben?
<i>Meanings</i>	<ul style="list-style-type: none"> • Wat zijn voor u de belangrijkste drijfveren om de bouwmaterialen te inspecteren / om deze methode/ tools toe te passen? • Wat vind u ervan dat deze materialen op deze manier worden geïnspecteerd? Kan het anders/efficiënter?
<i>Verdieping</i>	<ul style="list-style-type: none"> • Zijn er ook nog andere manieren om deze handeling uit te voeren en de bouwmaterialen te inspecteren? • Zouden daarbij andere tools ook handig kunnen zijn om deze handelingen uit te voeren? Welke zijn dat dan? • Vragen andere type bouwmaterialen een andere aanpak of plek om deze te inspecteren? Wat voor vaardigheden en tools/gereedschappen zijn daarbij nodig? • Moeten sommige materialen met meer dan 1 persoon worden behandeld om deze te inspecteren? • Met wie heeft u veel contact, werkt u veel samen of bent u afhankelijk van bij het uitvoeren uw werkzaamheden? Wat is zijn of haar functie?

Sorteren	
	<ul style="list-style-type: none"> • Wat is uw functie? En wat zijn uw belangrijkste dagelijkse werkzaamheden?
	<ul style="list-style-type: none"> • Wat zijn de belangrijkste aandachtspunten / wat heeft u zoal nodig als het gaat om het sorteren van de bouwmaterialen?
	<ul style="list-style-type: none"> • Waar zitten knelpunten/belemmeringen als het gaat om het sorteren van bouwmaterialen?
<i>Materials</i>	<ul style="list-style-type: none"> • Waar sorteert u de bouwmaterialen? • Welke tools en gereedschappen gebruikt u om deze handeling uit te kunnen voeren en de bouwmaterialen te sorteren?
<i>Competen.</i>	<ul style="list-style-type: none"> • Wat zijn belangrijke vaardigheden die bij het sorteren van materialen komen kijken? En welke kennis is handig om te hebben?

Meanings	<ul style="list-style-type: none"> • Wat zijn voor u de belangrijkste drijfveren om de bouwmaterialen te sorteren / om deze methode/ tools toe te passen?
	<ul style="list-style-type: none"> • Wat vind u ervan dat deze materialen op deze manier worden gesorteerd? Kan het anders/efficiënter?
Verdieping	<ul style="list-style-type: none"> • Zijn er ook nog andere manieren om deze handeling uit te voeren en de bouwmaterialen te sorteren?
	<ul style="list-style-type: none"> • Zouden daarbij andere tools ook handig kunnen zijn om deze handelingen uit te voeren? Welke zijn dat dan?
	<ul style="list-style-type: none"> • Vragen andere type bouwmaterialen een andere aanpak of plek om deze te sorteren? Wat voor vaardigheden en tools/gereedschappen zijn daarbij nodig?
	<ul style="list-style-type: none"> • Moeten sommige materialen met meer dan 1 persoon worden behandeld om deze te kunnen sorteren?
	<ul style="list-style-type: none"> • Met wie heeft u veel contact, werkt u veel samen of bent u afhankelijk van bij het uitvoeren uw werkzaamheden? Wat is zijn of haar functie?

Transporting	
	<ul style="list-style-type: none"> • Wat is uw functie? En wat zijn uw belangrijkste dagelijkse werkzaamheden?
	<ul style="list-style-type: none"> • Wat zijn de belangrijkste aandachtspunten / wat heeft u zoal nodig als het gaat om het transporteren van de bouwmaterialen?
	<ul style="list-style-type: none"> • Waar zitten knelpunten/belemmeringen als het gaat om het transporteren van bouwmaterialen?
Materials	<ul style="list-style-type: none"> • Waar slaat u de materialen op?
	<ul style="list-style-type: none"> • Welke tools en gereedschappen gebruikt u om deze handeling uit te kunnen voeren en de bouwmaterialen te transporteren?
Competen.	<ul style="list-style-type: none"> • Wat zijn belangrijke vaardigheden die bij het transporteren van materialen komen kijken? En welke kennis is handig om te hebben?
Meanings	<ul style="list-style-type: none"> • Wat zijn voor u de belangrijkste drijfveren om de bouwmaterialen te transporteren /deze methode/ tools toe te passen?
	<ul style="list-style-type: none"> • Wat vind u ervan dat deze materialen op deze manier worden getransporteerd? Kan het anders/efficiënter?
Verdieping	<ul style="list-style-type: none"> • Zijn er ook nog andere manieren om deze handeling uit te voeren en de bouwmaterialen te transporteren?
	<ul style="list-style-type: none"> • Zouden daarbij andere tools ook handig kunnen zijn om deze handelingen uit te voeren? Welke zijn dat dan?
	<ul style="list-style-type: none"> • Vragen andere type bouwmaterialen een andere aanpak qua transporteren? Wat voor vaardigheden en tools/gereedschappen zijn daarbij nodig?
	<ul style="list-style-type: none"> • Moeten sommige materialen met meer dan 1 persoon worden behandeld voor het transporteren?
	<ul style="list-style-type: none"> • Met wie heeft u veel contact, werkt u veel samen of bent u afhankelijk van bij het uitvoeren uw werkzaamheden? Wat is zijn of haar functie?

Appendix C – Tables of the practices

Description of the (core) Practices-as-entities

Introduction:

In this appendix, the (core) practices-as-entities are elaborated. The practices-as-entities (practices) are described in a table based on their practice name, case study specifics, description, and elements including materials, meanings, and competences. The core practices are presented in blue and the (normal) practices in orange:

	Core practice-as-entity
	Practice-as-entity

All practices are divided based on either the operational secondary building component supply processes, including the Open viewing day process, or the practices directly outside these processes. The operational secondary building component supply processes are the following: Quickscan, Open viewing day process, collecting, Preparing & Sorting for transport, Transportation, Sorting, Inspecting, Repairing / refurbishing / Remanufacturing, Preparing and Storing.

For each practice, it is described how often they were observed in the four case studies. The table of the practices will convey how often this was by the number ($n=x$). Some practices have been indicated with an 'H' (hypothetical). These hypothetical practices are indications derived from the data analysis. The description of the elements of the practices is only at a surface level. The elements are derived from the observations, interviews or data analysis. Only those which were deemed important have been described. For example, for conducting a Quickscan inventory, it was observed that a 'camera' (material element) is needed. Logic dictates those competence elements of 'how to use a camera' is required. However, such detailed description of all elements is deemed ineffective and is therefore neglected.

Core practices embedded within the supply processes

Quickscan process (disassembling site)

Process: Quickscan		
<i>Practice name</i>	Conduct Quickscan inventory N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practice entails doing a quick scan before the tender application to observe and making an inventory(list) of the potential secondary building components. Performances often include visiting the site and making photos, creating an inventory list directly afterward, performing minor calculations or measurements, calculating floor surface (m2). Some performances included a desk study to explore historical building usage and other characteristics.	
<i>Elements</i>	<i>Materials</i>	Camera (phone); inventory software.
	<i>Meanings</i>	Able to estimate the total market price of the potential secondary building components and calculate a discount for the tender in the hope of getting the project awarded; to maximize time for finding a potential buyer for the potential secondary building components; (for minimizing labor costs later); motivated by a specific demand of a buyer or client.
	<i>Competences</i>	Knowledge about which building components are profitable to dismantle from the building; knowledge about the time needed for dismantling and preparing each potential building component; knowledge about the state of the building components; knowledge about the amount of floor surface of the building; about accurate market pricing for building components; about how much time there is for the disassembly/collecting process.

Open viewing day process (disassembling site)

Process: Open viewing day		
<i>Practice name</i>	Organizing a open viewing day N=1	
	Only observed in the CBH case study of Hoogeboom.	
<i>Description</i>	This practice entails the organization of an open viewing day. Usually performed directly after the project is awarded. Performances often include visiting the disassembling site, making minor preparations at the assembling site, creating an public announcement, and other organizational performances	
<i>Elements</i>	<i>Materials</i>	Camera; website.
	<i>Meanings</i>	To maximize time for finding a potential buyer for the potential secondary building components; to minimize labor costs regarding collecting the secondary building components; to minimize transportation costs; to provide people emotionally attached to the building a change to collected any (emotional) valuable items.
	<i>Competences</i>	-

Process: Open viewing day		
<i>Practice name</i>	Performing a site visits and record (and communicate) the desired building components (performed by buyers)	N=1
<i>Case study specifics</i>	Only observed at the CBH of Hooigeboom.	
<i>Description</i>	This practices entails doing of a site visit including a minor inventory and record desired building components within the building. Hereafter, the recorded desired building components are communicated with Hooigeboom. This practices is performed by potential buyers of the secondary building components. Performances often include making photos, creating an inventory list, communicating with Hooigeboom via Whatsapp.	
<i>Elements</i>	<i>Materials</i>	Camera, phone (Whatsapp).
	<i>Meanings</i>	To buy potential cheap secondary building components; Motivated due to emotional value of the components within the building;
	<i>Competences</i>	Knowledge about which building components are profitable to acquire; knowledge about the state of the building components;

Process: Open viewing day		
<i>Practice name</i>	Performing calculations and communicate with potential buyers from the open viewing day	N=1
<i>Case study specifics</i>	Only observed at the CBH of Hooigeboom.	
<i>Description</i>	This practices entails the performing of calculations (balancing profits both in direct sales incomes and minimizing transportation) based upon the inquiries and desires from potential buyers from the open viewing day. Hereafter the inventory list of the secondary building components for each potential buyer is communicated with each buyer and price arrangements are made.	
<i>Elements</i>	<i>Materials</i>	Whatsapp; calculation software; photos from desired secondary building components.
	<i>Meanings</i>	To minimize transportation costs; To maximize sales; to provide people that are emotionally attached to the building a change to collected any (emotional) valuable items.
	<i>Competences</i>	Knowledge about which building components are profitable to dismantle from the building; Knowledge on de demand of potential buyers; about accurate market pricing for building components; about the floorplan of the demolition/disassembly site (for calculating transportation movements);

Process: Open viewing day		
<i>Practice name</i>	Pre-disassembling secondary building components (performed by buyers) N=1	
<i>Case study specifics</i>	Only observed at the CBH of Hoogeboom.	
<i>Description</i>	This practice entails the (careful), often by hand, disassembling of building components from the building structures. Hereafter, building components are being brought outside to a transportation device. This practice is performed by potential buyers of the secondary building components. Performances often include: unscrewing, (neatly) pulling loose (by hand or with a tool), sawing out, etc. Removing components from the building structures by hand or a small transportation rack on wheels.	
<i>Elements</i>	<i>Materials</i>	Electrical screwdriver/drill; general hand tools; transportation rack on wheels
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully;
	<i>Competences</i>	Knowledge of working with the necessary tools; knowledge of technical constructions; knowledge about which building components can be disassembled.

Inventory process (disassembling site)

Process: Inventory		
<i>Title</i>	Conduct detailed inventory, create list of potential secondary building components N=3	
<i>Case study specifics</i>	Usually, only observed at the CBH of 2dehandsbouwmaterialen, BORK Groep, and ADEX.	
<i>Description</i>	This practice entails conducting an inventory at the disassembling location after the project is awarded to create a detailed inventory list of the potential secondary building components that must be disassembled. Performances often include checking every room of the building, making photos, creating a detailed inventory list (usually in an app) including the quantities and qualities of the potential secondary building materials, dimensions, how it is attached to the building (with nails, screws, glue, etc.). In some performances, it also entails minor destructive research, for example, removing paint or making small holes to look behind a wall.	
<i>Elements</i>	<i>Materials</i>	Pre-filled lists from the Quicksan, tape measure device, knife, Phone (camera), inventory software.
	<i>Meanings</i>	Aim is to maximize time for finding a potential buyer for the potential secondary building components; aim is to show client of the potentials of reuse and provide a circular mindset to the clients; motivation is the demand of the client to provide such a calculation; motivation to make supply processes more efficient (financially more attractive),
	<i>Competences</i>	Knowledge about which building components are profitable to dismantle from the building; Knowledge on the demand of potential buyers; about the time needed for dismantling and preparing each potential building component; about engineering aspects of constructions; about accurate market pricing for building components; about the floorplan of the demolition/disassembly site (for calculating transportation movements); about how much time there is for the disassembly/collecting process.

Collecting process (disassembling site)

Process: Collecting		
<i>Practice name</i>	Disassemble secondary building components from building structures N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the (careful) and efficient, often by hand, disassembling of building components from the building structures. Performances often include: unscrewing, (neatly) pulling lose (by hand or with a tool), sawing out, and putting all the loose building components aside. The performances of the disassembly of a building usually takes places from the top to the bottom.	
<i>Elements</i>	<i>Materials</i>	Telehandler, special cart lift, electrical screwdriver/drill, general hand tools, list of which building components need to be disassembled (from inventory), special equipment for sawing appropriate dimensions (gipsplaten)
	<i>Meanings</i>	Aim to make it as easy as possible, whiles being timely efficient, for preparing the secondary building components at the hub; having joy in disassembling (instead of demolishing); drive for reusing secondary building components.
	<i>Competences</i>	Knowledge of working with the necessary tools; patience for working carefully; knowledge of technical constructions; knowledge about which building components need to be reused.

Process: Collecting		
<i>Practice name</i>	Pack/load disassembled secondary building components onto small carrier N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the (careful) and efficient loading and/or packing of disassembled building components into or onto a small carrying device for transporting the components outside or away from the building structures. Performances often include: Stacking or loading secondary building components onto a transport rack, transport cart, trolley, or transport 'bok',	
<i>Elements</i>	<i>Materials</i>	Telehandler, crats, transport rack, transport cart, transport 'bok',
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully; Motivation to efficiently prepare the secondary building components for transportation outside or away from building structures; Motivation to lift as few as possible building components by hand.
	<i>Competences</i>	Patience for working carefully; knowledge about which building components need to be removed from the building structures; knowledge about floor plan of the building structures/ its surroundings.

Process: Collecting		
<i>Practice name</i>	Conduct visual (pre) inspection of secondary building components	N=3 (H)
<i>Case study specifics</i>	Observed at all examined case studies. However, 2dehandsbouwmaterialen only performs this occasionally because most components are collected by M. Heezen and Vissers which mostly do not perform this practices.	
<i>Description</i>	This practices entails a quick inspection of the secondary building components coming from the building structures. Performances often include: a quick inspection with hand and eye of the secondary building components.	
<i>Elements</i>	<i>Materials</i>	-
	<i>Meanings</i>	Drive for reusing and selling secondary building components;
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge about the manner in which building components were disassembled; Knowledge about which building g components are profitable to sell; Knowledge about what dimensions certain standard sized building component materials need to be.

Process: Collecting		
<i>Practice name</i>	Remove secondary building components from building structures (carry, lift, push)	N=4
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the (careful) and efficient carrying, lifting or pushing out the disassembled building components from the building structures to a certain collecting area on the disassembling site. Performances often include: carrying components out or away by hand (sometimes utilizing staircase or lift), or pushing or using a fork lift (truck) to transport rack, transport cart or trolley or using a telehandler or crane to remove them from a higher level (e.g. trough window).	
<i>Elements</i>	<i>Materials</i>	Telehandler, crane, transport rack, transport cart, forklift (truck), lift, trolley.
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully;
	<i>Competences</i>	Patience for working carefully; knowledge about which building components need to be removed from the building structures; knowledge about floor plan of the building structures/ its surroundings.

Preparing & Sorting before transport process (disassembling site)

Process: Preparing before transport		
<i>Practice name</i>	(Pre) sort secondary building components, place in various transport-racks for transportation N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the (careful) and efficient sorting of disassembled building components from the building structures into certain carrying devices. Performances often include: Sorting different secondary building components onto different stacks, pallets, crates, transport rack, transport cart, open or closed containers, bokjes, a truck, car, trailer, shipping container, pallets, bokken, transport rack, 20/40 cubic meter container and often away from the main demolition locations as such that the components are safe from being damaged. The performances are either by hand or with machines such as forklift truck or a lifting crane.	
<i>Elements</i>	<i>Materials</i>	Telehandler, crane, transport rack, transport cart, forklift truck, a truck, car, (covered) trailer, shipping container, pallets, bokken, transport rack, 20/40 cubic meter container
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully; Drive that pre-sorting the secondary building components and putting them on a carrying devices is more efficient in the entire supply process; Motivation for protecting the secondary building components as such that they can be reused;
	<i>Competences</i>	Knowledge about which building components need to be sorted; Knowledge about which, how many and the variation of secondary building components that potentially are being reused from the building structures;

Process: Preparing before transport		
<i>Practice name</i>	Prepare secondary building components at wrapping, binding, stacking, and/or compressing N=2	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, 2dehandsbouwmaterialen, Hoogeboom.	
<i>Description</i>	This practices entails the (careful) preparing the secondary building components before transport from the disassembling site by wrapping with foil and/or compressing of disassembled building components from the building structures. Performances often include: wrapping different secondary building components and stacking them onto different pallets, crates, transport rack, and sometimes binding them with special equipment. Performances are usually by hand.	
<i>Elements</i>	<i>Materials</i>	Crane, transport rack, transport cart, forklift truck, pallets, transport rack, binding equipment, foil, compressing machine.
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully; Drive that pre-sorting the secondary building components and putting them on a carrying devices is more efficient on the hub; Motivation for protecting (e.g. from weather conditions) the secondary building components as such that they can be reused;
	<i>Competences</i>	Knowledge about which building components need to be sorted; Knowledge about which, how many and the variation of secondary building components that are potentially are being reused from the building structures;

Transportation process (disassembling site – circular building hub)

Process: Transporting		
<i>Practice name</i>	Load secondary building components / carrying devices onto transport device N=4	
<i>Case study specifics</i>	Observed at all examined CBH case studies.	
<i>Description</i>	This practices entails the (careful) and efficient loading of disassembled building components from on nearby the building structures into a certain transportation devices. Performances often include: loading components into a truck, car, trailer, shipping container, 20/40 cubic meter container either by hand or with machines such as forklift, lifting crane.	
<i>Elements</i>	<i>Materials</i>	Crane, transport rack, transport cart, forklift truck, a truck, car, (covered) trailer, shipping container, pallets, bokken, trolly, transport rack, 20/40 cubic meter container, shipping container, binding equipment,
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully; Drive for working efficient to safe space and time and reduce costs;
	<i>Competences</i>	Knowledge about which building components need to be reused; Knowledge about which building components need to be protected from weather conditions; Knowledge about packing the building components efficiently;

Process: Transporting		
<i>Practice name</i>	Transport secondary building components to CBH, third parties, or client N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the transportation (driving) of the secondary building components from the building structures to the circular building hub, to a third party that performance one or more of the supply processes (e.g. repairing) or directly to the client. Performances often include: driving with a loaded truck, car, (covered) trailer, shipping container (20/40 cubic meter).	
<i>Elements</i>	<i>Materials</i>	Truck, car, (covered) trailer, shipping container (20/40 cubic meter).
	<i>Meanings</i>	-
	<i>Competences</i>	Knowledge about when which building components need to be picked-up; Knowledge about where building components need to be delivered.

Process: Transporting		
<i>Practice name</i>	Position transport device on circular building hub	N=4
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the placing (driving) of the transportation device of the circular building hub. Performances often include: driving with a loaded truck, car, (covered) trailer, shipping container (20/40 cubic meter), placing it statically on the site of the circular building hub and possibly relocating (certain parts of) the transportation devices with a forklift truck.	
<i>Elements</i>	<i>Materials</i>	Truck, car, (covered) trailer, shipping container (20/40 cubic meter), forklift truck.
	<i>Meanings</i>	Making other supply processes on the circular building hub more efficient;
	<i>Competences</i>	Knowledge about the floorplan of the circular building hub;

Sorting process (circular building hub)

Process: Sorting		
<i>Practice name</i>	Unload, sort, divide secondary building components into piles/locations or onto different carrying/storage devices	N=4
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practices entails the careful and efficient unloading and sorting of disassembled building components from transportation device and divide them into different piles or locations or neatly onto different carrying/storage devices from the transportation devices. Performances often include: Unloading the secondary building components. Neatly, sorting different secondary building components onto different stacks, pallets, crates, transport rack, transport cart, open or closed containers, bokken or divide them onto a pile or location (indoor or outdoor) on the hub, possibly based on material types, dimensions, and/or characteristics. The performances are either by hand or with machines such as forklift truck or a wheelbarrow.	
<i>Elements</i>	<i>Materials</i>	Transport rack, transport cart, forklift truck, pallets, bokken, transport rack, wheelbarrow.
	<i>Meanings</i>	Drive for reusing secondary building components and thus handle components carefully; Drive that sorting the secondary building components and putting them on a carrying devices is more efficient on the hub; Motivation for protecting the secondary building components as such that they can be reused; avoiding that potential buyers are pulling secondary building components from big stacks and thereby damaging other components;
	<i>Competences</i>	Knowledge about which building components need to be sorted; Knowledge about which building components are already sold; Knowledge about which, how many and the variation of secondary building components that are potentially are being reused from the building structures;

Inspecting process (circular building hub)

Process: Inspecting		
<i>Practice name</i>	Conduct visual inspection of secondary building components N=2	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, 2dehandsbouwmaterialen. However, ADEX Groep only performs this occasionally and normally only with timber components. BORK Groep only performs this after the Storing process.	
<i>Description</i>	This practices entails a quick inspection of the secondary building components coming from the transportation devices. Performances often include: a quick inspection with hand and eye of the secondary building components.	
<i>Elements</i>	<i>Materials</i>	-
	<i>Meanings</i>	Drive for reusing and selling secondary building components; Motivation for protecting the secondary building components as such that they can be reused;
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge about the manner in which building components were disassembled; Knowledge about which building components need to be protected from weather conditions; Knowledge about which building components are profitable to sell; Knowledge on de demand of potential buyers; Knowledge about what dimensions certain standard sized building component materials need to be.

Repairing, Refurbishing and Remanufacturing process (circular building hub)

Process: Repairing, Refurbishing and Remanufacturing		
<i>Practice name</i>	Saw wooden secondary building components into (standardized) sizes (remanufacturing) N=2	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep and 2dehandsbouwmaterialen. Occasionally performed by Hoogetboom, but only during special circumstances.	
<i>Description</i>	This practices entails the sawing of wooden secondary building components as such that they can be reused again. Performances often include: a quick inspection of a piece of timber and estimating the desired length and sawing it with a electrical automated saw indoors.	
<i>Elements</i>	<i>Materials</i>	Electrical saw, indoor workplace, safety materials (e.g. glass and earplugs), equipment for the electrical saw.
	<i>Meanings</i>	Drive for reusing and selling secondary building components;
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge about which building components are profitable to sell; Knowledge on de demand of potential buyers; Knowledge about what dimensions certain standard sized building component materials need to be.

Process: Repairing, Refurbishing and Remanufacturing		
<i>Practice name</i>	Polish secondary building components: timber (refurbish) N=1	
<i>Case study specifics</i>	Only observed at the CBH of 2dehandsbouwmaterialen because they have a specific buyer.	
<i>Description</i>	This practices entails the removing of nails from wooden secondary building components as such that they can be reused again. Performances often include: a quick inspection of a piece of timber and estimating whether it is repairable and removing all or most visual or longest nails either by hand with an hammer or using a air pressured nail removal device.	
<i>Elements</i>	<i>Materials</i>	Hammer, air pressured nail removal device, indoor workplace, safety materials (e.g. glass and earplugs), something like a table.
	<i>Meanings</i>	Drive for reusing and selling secondary building components; Making secondary building components more attractive for (potential) buyers.
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge about which building components are profitable to sell; Knowledge on de demand of potential buyers; Knowledge about when it is still profitable to execute the performance of the practice (time vs. workload); Knowledge about how to handle a nail removal tool.

Process: Repairing, Refurbishing and Remanufacturing		
<i>Practice name</i>	Cleaning secondary building components: toilets (refurbish) N=1	
<i>Case study specifics</i>	Only observed at the CBH of 2dehandsbouwmaterialen because they have a specific buyer.	
<i>Description</i>	This practices entails the removing of nails from wooden secondary building components as such that they can be reused again. Performances often include: repairable and removing all or most visual or longest nails either by hand with an hammer or using a air pressured nail removal device.	
<i>Elements</i>	<i>Materials</i>	Hammer, air pressured nail removal device, indoor workplace, safety materials (e.g. glass and earplugs), something like a table.
	<i>Meanings</i>	Drive for reusing and selling secondary building components; Making secondary building components more attractive for potential buyers.
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge about which building components are profitable to sell; Knowledge on de demand of potential buyers; Knowledge about when it is still profitable to execute the performance of the practice (time vs. workload); Knowledge about how to handle a nail removal tool.

Process: Repairing, Refurbishing and Remanufacturing		
<i>Practice name</i>	Remove nails from wooden secondary building components (repair) N=4	
<i>Case study specifics</i>	Observed at all examined case studies. However, Hoogetboom only performs this with larger nails.	
<i>Description</i>	This practice entails the removing of nails from wooden secondary building components as such that they can be reused again. Performances often include: a quick inspection of a piece of timber and estimating whether it is repairable and removing all or most visual or longest nails either by hand with an hammer or using a air pressured nail removal device.	
<i>Elements</i>	<i>Materials</i>	Hammer, air pressured nail removal device, indoor workplace, safety materials (e.g. glass and earplugs), something like a table.
	<i>Meanings</i>	Drive for reusing and selling secondary building components; Making secondary building components more attractive for potential buyers.
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge about which building components are profitable to sell; Knowledge on de demand of potential buyers; Knowledge about when it is still profitable to execute the performance of the practice (time vs. workload); Knowledge about how to handle a nail removal tool.

[Preparing process \(circular building hub\)](#)

Process: Preparing		
<i>Practice name</i>	Prepare secondary building components (stacked on carrier) for storage/transport N=3	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, 2dehandsbouwmaterialen and Hoogetboom.	
<i>Description</i>	This practice entails the carefully and neatly preparing of secondary building components for storage or transport by wrapping secondary building components, that were often stacked on a carrying device such as a pallet, with binding materials such as foil or linen or rope. Performances often include: stacking secondary building components with little pieces of timber in between them onto pallets or on bokken either by hand or using a forklift truck,	
<i>Elements</i>	<i>Materials</i>	Foil, linen, rope,
	<i>Meanings</i>	Drive for protecting secondary building components; Clients wants the secondary building components packed with foil.
	<i>Competences</i>	Knowledge about which building components are profitable to sell; Knowledge on de demand of potential buyers; Knowledge about which building components need to be protected;

Process: Preparing		
<i>Practice name</i>	Create detailed inventory list of secondary building components information	N=3
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, 2dehandsbouwmaterialen, and Hoozeboom.	
<i>Description</i>	This practice entails the making of a list of diverse information details about the secondary building components. Performances often include: the calculating and measuring of different factors such as quantities, characteristics, dimensions and weight. Usually it also involves making photo's.	
<i>Elements</i>	<i>Materials</i>	Camera (mobile phone), scale (for weighing),
	<i>Meanings</i>	Putting the secondary building components on a market place for selling them; knowing what the potential pricing is for the secondary building components;
	<i>Competences</i>	Knowledge about what information potential buyers want to know about the secondary building components; Calculating certain factors;

Core practices directly outside the supply processes		
<i>Practice name</i>	Certify diverse secondary building components (external companies) (after Transporting	N=1
<i>Case study specifics</i>	Only observed at the CBH of ADEX Groep.	
<i>Description</i>	This entails the certifying of diverse secondary building components. Examples are Wood, plaster walls, and suspended ceiling.	
<i>Elements</i>	<i>Materials</i>	Certificate to conduct the certification process;
	<i>Meanings</i>	Drive to sell secondary building components; demand of the buyer;
	<i>Competences</i>	Competence to assess and certify the various secondary building components; understanding the relevant standards and regulations;

Storing process (circular building hub)

Process: Storing		
<i>Practice name</i>	Store secondary building components (indoors/outdoors) at the CBH N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This practice entails the carefully and neatly storing of the secondary building components either indoors or outdoors at the location of the circular building hub. Performances often include: carrying, lifting or rolling the secondary building components or loaded carrying devices on a place indoor or outdoor at the CBH. Indoors can be barn or closed shipping container. Either by hand or using a forklift (truck) or wheelbarrow.	
<i>Elements</i>	<i>Materials</i>	Forklift (truck), wheelbarrow, shipping container, barn (shelter).
	<i>Meanings</i>	Drive for protecting (and keeping them clean) secondary building components; Making secondary building components more attractive for potential buyers; avoiding that potential buyers are pulling secondary building components from big stacks and thereby damaging other components; Keeping an overview of all the secondary building components on the hub;
	<i>Competences</i>	Knowledge about which building components are profitable to sell; Knowledge on the demand of potential buyers; Knowledge about which building components need to be protected (from weather conditions); Knowing when the client needs the secondary building components;

Core practices directly outside the supply processes

Core practices directly outside the supply processes		
<i>Practice name</i>	List inventory on a marketplace (after Preparing) N=3	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, 2dehandsbouwmaterialen, and Hoogboom. Occasionally performed by BORK Groep, but only during special circumstances.	
<i>Description</i>	This practice entails putting the building components that arrived on the hub on a marketplace. Performances often include: making a picture, or using existing pictures, and counting quantities, in some specific cases (e.g. specific technological installations) searching and calculating pricing,	
<i>Elements</i>	<i>Materials</i>	Marketplace (Marktplaats Insert Materiaal Scout); Devices (Laptop, Internet); List of building component and their characteristics; Pictures of the inventory of building components;
	<i>Meanings</i>	Enhance the sales of secondary building components;
	<i>Competences</i>	Knowledge about accurate market pricing; knowledge about which materials are left/coming over to the hub; Knowledge about the functionality of secondary building components; Knowledge on the demand of potential buyers;

Core practices directly outside the supply processes		
<i>Practice name</i>	Contact potential buyers to sell inventory (after Preparing)	N=3 (H)
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, 2dehandsbouwmaterialen, and Hoozeboom. Occasionally performed by BORK Groep, but only during special circumstances.	
<i>Description</i>	This entails actively contacting (calling or emailing) possible buyers that are interested in buying the inventory of building components that will arrive / or are at the Hub.	
<i>Elements</i>	<i>Materials</i>	Contact details of potential buyers; List of building component and their characteristics; Pictures of the inventory of building components;
	<i>Meanings</i>	Enhance the sales of secondary building components;
	<i>Competences</i>	Knowledge about accurate market pricing; knowledge about which materials are left/coming over to the hub; Knowledge about the functionality of secondary building components; Knowledge on de demand of potential buyers;

Core practices directly outside the supply processes		
<i>Practice name</i>	Calculate potential profit margins (before Collecting)	N=4
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails calculating the potential profit from selling the potential secondary building components from the dismantling site (building) and calculating the potential discount on the project. This happens prior to the disassembly of the building.	
<i>Elements</i>	<i>Materials</i>	-
	<i>Meanings</i>	To get the project awarded (financial drive);
	<i>Competences</i>	Knowledge about accurate market pricing for building components, about which building components are profitable to dismantle from the building, about the time needed for dismantling and preparing each potential building component, and about the floorplan of the demolition/dismantling site (for calculating transportation movements).

Core practices directly outside the supply processes		
<i>Practice name</i>	Present potential inventory to buyers, track sold building components (before/during Collecting to Transporting) N=3	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, BORK Groep, and Hooigeboom. Occasionally performed by 2dehandsbouwmaterialen, but only during special circumstances.	
<i>Description</i>	This entails actively contacting (calling or emailing) possible buyers that are interested in buying the potential inventory of building components that are prone to be dismantled. Relay information regarding the building components (quantities, characteristics, etc.), but also when the building components are ready to be picked up or delivered (pre-plan in terms of time). Possibly specifically when unknown large quantities of building components have been inventoried that are unusual.	
<i>Elements</i>	<i>Materials</i>	Pictures of the potential inventory of building components; Contact details of potential buyers
	<i>Meanings</i>	Enhance the sales of secondary building components; To maximize time for finding a potential buyer for the potential secondary building components; to minimize labor costs regarding collecting the secondary building components; to minimize transportation costs;
	<i>Competences</i>	Knowledge on de demand of potential buyers, about accurate market pricing, about which building components are on the potential inventory of building components.

Core practices directly outside the supply processes		
<i>Practice name</i>	List inventory on a marketplace (before/during Collecting to Transporting) N=2	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, BORK Groep, and Hooigeboom. Occasionally performed by 2dehandsbouwmaterialen, but only during special circumstances.	
<i>Description</i>	This practice entails the putting the building components from the inventory or quickscan list on a marketplace. This practices in conducted prior to the actual disassembling of the building components.	
<i>Elements</i>	<i>Materials</i>	Pictures of the potential inventory of building components; Pictures of the potential inventory of building components;
	<i>Meanings</i>	Enhance the sales of secondary building components; To maximize time for finding a potential buyer for the potential secondary building components; to minimize labor costs regarding collecting the secondary building components; to minimize transportation costs;
	<i>Competences</i>	Knowledge on de demand of potential buyers; about accurate market pricing; about which building components are on the potential inventory of building components.

Core practices directly outside the supply processes		
<i>Practice name</i>	Compare inventory list to disassembled components, calculate time spent (before Collecting) N=3	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, BORK Groep, and Hooigeboom.	
<i>Description</i>	This entails the calculation of the differences between what was initially put on the inventory list during the inventory process, and what actually came out of the building. Moreover, it is the calculation of the actual time spend on the disassembly of the building components. Performances often include making a lot of pictures of all the secondary building components and possibly handing over results to clients or to companies that regulate SVMS007 norms.	
<i>Elements</i>	<i>Materials</i>	List with all the building components inventoried in advance, the inventory software for calculation;
	<i>Meanings</i>	Motivation to make processes more efficient (financially more attractive), drive due to demands of the client (sustainability goals); motivation is that it is required according to the SVMS007 norm; motivation because the clients is demanding it;
	<i>Competences</i>	Knowledge about time spend on the disassembly of building components;

Core practices directly outside the supply processes		
<i>Practice name</i>	Monitor sales (before Storing) N=3	
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep, BORK Groep, and Hooigeboom.	
<i>Description</i>	This entails the active track keeping of which secondary building components have been sold during the whole supply process. Performances often include making a list of what is being sold.	
<i>Elements</i>	<i>Materials</i>	List with all the building components inventoried in advance during the inventory process;
	<i>Meanings</i>	Motivation to make the storing processes more efficient; motivation is that it is required according to the SVMS007 norm; motivation because the clients is demanding it;
	<i>Competences</i>	Knowledge the building components that were inventoried in advance during the inventory process; knowledge about which building components have been sold;

Core practices directly outside the supply processes		
<i>Practice name</i>	Identify building component requirements by reaching out to potential buyers (before Quicksan)	N=3 (H)
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails actively contacting (calling or emailing) possible buyers that are interested in buying secondary building components and create an overview of what the general demands are in the secondary building component market.	
<i>Elements</i>	<i>Materials</i>	To maximize time for finding a potential buyer for the potential secondary building components; (for minimizing labor costs later);
	<i>Meanings</i>	Motivation is that this knowledge helps making the supply process more efficient by targeting the right secondary building components; to maximize time for finding a potential buyer for the potential secondary building components; to minimize labor costs regarding collecting the secondary building components; to minimize transportation costs;
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Record actual disassembly time for building components (after Collecting)	N=1 (H)
<i>Case study specifics</i>	Only examined at the CBH of ADEX Groep.	
<i>Description</i>	This entails writing down for individual building components how long it took to disassemble them from a building and prepare them for transportation.	
<i>Elements</i>	<i>Materials</i>	-
	<i>Meanings</i>	Aim is to show client of the potentials of reuse and provide a circular mindset to the clients; motivation is the demand of the client to provide such a calculation; motivation to make supply processes more efficient (financially more attractive).
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Develop a disassembly plan, including time, location, logistics, and machinery (before Collecting) N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails the creation of a disassembly plan for the disassembled building components. It involves creating a timely order of when, where, and which building components should be disassembled, where they can be (temporarily) located, planning where they need to go for transportation, and planning all the needed machinery (time and dates). Either include a detailed plan presented on paper, or an overall schedule that one or more employees think about.	
<i>Elements</i>	<i>Materials</i>	Photos from the disassembly location and the potential secondary building components, drawings, and schedules of the demolition plan and site.
	<i>Meanings</i>	Aim to make the disassembly processes more efficient (financially more attractive); motivation that it is required according to the SVMS007 norm.
	<i>Competences</i>	Knowledge about how to disassemble building components (efficient) and what tools and machinery are required for the practice, knowledge about the disassembling site layout, knowledge about planning of other stakeholders; about the time needed for dismantling and preparing each potential building component; knowledge about the state of the building components;

Core practices directly outside the supply processes		
<i>Practice name</i>	Motivate, enthuse, and guide the disassembly team (during Collecting to Transporting) N=4	
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails actively motivating the disassembly team to work efficiently and handle secondary building components carefully. Moreover, show them what is happening with the secondary building components and explaining all the benefits in comparison to demolishing them.	
<i>Element</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	Have the (social) skills to motivate people

Core practices directly outside the supply processes		
<i>Practice name</i>	Calculate CO2 emissions savings due to the reuse of building components, and share these with the clients. N=1	
<i>Case study specifics</i>	Only examined at the CBH of ADEX Groep.	
<i>Description</i>	This entails the calculation of how much CO2 is potentially saved by the secondary building components that derive from the disassembly site and then sharing them with the client.	
<i>Elements</i>	<i>Materials</i>	Inventory list of the actual secondary building components that came out of the building and were prepared for reuse,
	<i>Meanings</i>	The aim is to provide a circular mindset to the clients, motivation is the demand of the client to provide such a calculation, motivation is to try to make a distinction from other companies.
	<i>Competences</i>	Knowledge on CO2 emissions from diverse secondary building components.

Core practices directly outside the supply processes		
<i>Practice name</i>	Create transportation schedule (before Transportation)	N=1 (H)
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails the making of a transportation planning to transport the secondary building components that derive from the disassembly site to the circular building hub, to a third party that performance one or more of the supply processes (e.g. repairing) or directly to the client.	
<i>Elements</i>	<i>Materials</i>	Inventory list of the amount of secondary building components that came out of the building structures;
	<i>Meanings</i>	The aim is to make the transportation process more efficient;
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Remanufacture secondary building components: Timber (external companies) (after Transportation)	N=1
<i>Case study specifics</i>	Only observed at the CBH of BORK Groep.	
<i>Description</i>	This practices entails the sawing of wooden secondary building components as such that they can be reused again. Performances often include: a quick inspection of a piece of timber and estimating the desired length and sawing it with a electrical automated saw indoors	
<i>Elements</i>	<i>Materials</i>	Electrical saw, indoor workplace, safety materials (e.g. glass and earplugs), equipment for the electrical saw.
	<i>Meanings</i>	Demand of potential buyer; Demand of the CBH to perform this practice;
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge on de demand of the CBH; Knowledge about what dimensions certain standard sized building component materials need to be.

Core practices directly outside the supply processes		
<i>Practice name</i>	Remove nails from wooden secondary building components (repair) (external companies) (after Transportation)	N=1
<i>Case study specifics</i>	Only observed at the CBH of BORK Groep	
<i>Description</i>	This practices entails the removing of nails from wooden secondary building components as such that they can be reused again. This practices is performed by individuals not directly involved with the operational supply processes. Performances often include: a quick inspection of a piece of timber and estimating whether it is repairable and removing all or most visual or longest nails either by hand with an hammer or using a air pressured nail removal device.	
<i>Elements</i>	<i>Materials</i>	Hammer, indoor workplace, safety materials (e.g. glass and earplugs), something like a table.
	<i>Meanings</i>	Demand of potential buyer; Demand of the CBH to perform this practice;
	<i>Competences</i>	Knowledge about the functionality of secondary building components; Knowledge on de demand of the CBH; Knowledge about how to handle a nail removal tool.

Core practices directly outside the supply processes		
<i>Practice name</i>	Issuing an order for the disassembly (external companies, client) (before Quicksan)	N=4
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails issuing the order for the disassembly to the Hub.	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Plan and coordinate demolition site (external companies/internal) (before/during Collecting to Transporting)	N=2 (H)
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails planning and coordinating the demolition site (since often demolishing and disassembling are performed together.)	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Dismantle technical installations (external companies) (during Collecting)	N=2 (H)
<i>Case study specifics</i>	Only observed at the CBHs of ADEX Groep and BORK Groep.	
<i>Description</i>	This entails the disassembling of diverse technical installations direct from the building or from the disassembling site.	
<i>Elements</i>	<i>Materials</i>	-
	<i>Meanings</i>	Focusses on technical installation;
	<i>Competences</i>	Specific technical knowledge about technological installations; Specific knowledge about market for technological installations;

Core practices directly outside the supply processes		
<i>Practice name</i>	Demolish the building (external companies/internal)	N=3 (H)
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails the demolishing of the building (since often demolishing and disassembling are performed together.)	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Create upfront reuse inventory (client, external company) (before Collecting)	N=3 (H)
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails the creation of an inventory list by the client (often in collaboration with for example an architect) regarding which building components can/should be reused.	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Place order for specific secondary building components (external buyer).	N=4
<i>Case study specifics</i>	Observed at all examined case studies.	
<i>Description</i>	This entails the	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Visit CBH to acquire potential secondary building components (after preparation) (external buyer).	N=4
<i>Case study specifics</i>	Observed at all examined case studies. However, only occasionally at ADEX Groep and BORK Groep.	
<i>Description</i>	This entails	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Core practices directly outside the supply processes		
<i>Practice name</i>	Assessing whether CBHs have performed supply processes in accordance with SVMS007 regulation	N=1
<i>Case study specifics</i>	Only examined at the CBH of Hoogeboom.	
<i>Description</i>	<p>This practice entails coming to check during and after the supply processes what has happened. Assessing whether CBHs have reused high-quality materials, whether they met the reuse requirement, etc.</p> <p>Practice conducted by institution of SVMS007. This is a legislation, protocol on how disassembling and processing of secondary building components should be done. Performances often include verifying whether all practices and processes that were performed align with laws and regulations.</p>	
<i>Elem</i>	<i>Materials</i>	-
	<i>Meanings</i>	-
	<i>Competences</i>	-

Appendix E - The scoring table: Frequency and influence (1/2)

Legend
 Freq. Frequency
 Influ. Influence
 X Known by participant - Data calculated based on average (mean) from other variables
 Known by participant - Not calculated due to insufficient data
 Overall impact class = based on classes: low (1), medium (2), and high (3)

Constraining factors	Category	BORK Groep (CBH)			ADEX Groep (CBH)			Hoogebom			2dehandsbouwmaterialen			INSERT			Total	Overall impact class	Overall impact class 2	Average Freq.	Average Influ.	Total change scores		
		Freq.	Influ.	change scores	Freq.	Influ.	change scores	Freq.	Influ.	change scores	Freq.	Influ.	change scores	Freq.	Influ.	change scores								
Certification of employees and buyers (e.g., safety).	Regulatory	1	2	1	0	1	1	1	1	1	0	2	1	-1	0	1	1	1	9	1,0	1,0	0,8	1,2	2
Secondary building components break during transport.	Organizational	0	1	1	1	1	0	2	1	-1	1	2	1	1	2	2	1	1	11	2,0	1,0	1,0	1,4	2
Uncertainty as to whether the (disassembling) project will be awarded.	Economic	1	1	0	1	1	0	1	1	0	2	2	0	1	1	0	1	0	12	2,0	1,0	1,2	1,2	0
Fragile secondary building components.	Technical	1	1	0	2	1	-1	2	1	-1	2	1	-1	1	1	0	1	0	13	2,0	1,0	1,6	1,0	-3
Lack of knowledge regarding old building components inside the buildings (that are prone to being disassembled).	Organizational	1	1	0	1	1	0	2	1	-1	2	2	0	1	1	0	1	0	13	2,0	1,0	1,4	1,2	-1
(Last minute) changes in the planning for the disassembling and demolition.	Organizational	2	1	-1	2	1	-1	2	1	-1	2	3	1	1	1,5	0,5	1	0,5	16	2,0	2,0	1,8	1,5	-1,5
Lack of space at the CBH (due to high costs).	Organizational	2	1	-1	1	1	0	2	1	-1	3	3	0	1	1,5	0,5	1	0,5	16	2,0	2,0	1,8	1,5	-1,5
Lack of standardized sizes for secondary building components.	Economic	1	3	2	1	2	1	1	3	2	1	2	1	1	3	2	1	2	16	2,0	2,0	1,0	2,6	8
Mindset of the demolition/disassembling workers.	Social	2	1	-1	1	1	0	2	1	-1	2	2	0	2	2	0	2	0	16	2,0	2,0	1,8	1,4	-2
Demand for custom-made building components by the construction sector.	Economic	2	2	0	2	2	0	2	2	0	2	1	-1	1	1	0	1	0	17	2,0	2,0	1,8	1,6	-1
Societal ideas about the quality of secondary building components.	Social	2	2	0	2	2	0	2	2	0	1	2	1	1	2	1	1	1	17	2,0	2,0	1,6	2,0	2
Too large quantities of specific building components coming from large disassembling projects.	Economic	1	1	0	2	1	-1	3	1	-2	2	2	0	2	2	0	2	0	17	2,0	2,0	2,0	1,4	-3
Incorrect (too tight or too long in terms of time) disassembling schedule.	Organizational	2	1	-1	1	1	0	2	1	-1	3	3	0	2	1,5	-0,5	2	-0,5	18	2,0	2,0	2,0	1,5	-2,5
Too high or wrong expectations regarding reusable secondary building components due to pre-inventory.	Organizational	1	3	2	1	2	1	1	3	2	2	3	1	1,25	3	1,75	1	1,75	18,5	2,0	2,0	1,3	2,8	7,75
Too little time for the inventory/Quicksan phase.	Organizational	2	2	0	2	1	-1	1	3	2	3	3	0	1	2	1	1	1	19	2,0	2,0	1,8	2,2	2
dismantling buildings can lead to damaged building components.	Technical	2	2	0	2	2	0	2	2	0	2	2	0	2	3	1	1	1	20	2,0	2,0	2,0	2,2	1
Too little time (to store) and space on the disassembling site.	Organizational	2	1	-1	2	1	-1	3	1	-2	3	2	-1	2,5	2	-0,5	2	-0,5	20	2,0	2,0	2,5	1,4	-5,5
Lack of knowledge regarding the market of secondary building components or appropriate mindset by diverse stakeholders.	Social	2	2	0	2	2	0	3	2	-1	3	2	-1	3	3	0	3	0	24	3,0	3,0	2,6	2,2	-2
Supply of secondary building components inconsistency.	Economic	3	2	-1	3	2	-1	3	2	-1	2	2	0	2,75	2	-0,75	2	-0,75	24,5	3,0	3,0	2,8	2,0	-3,75
Labor force scarcity in the labor market	Economic	3	3	0	1	1	0	3	3	0	3	3	0	3	2	-1	3	-1	26	3,0	3,0	2,6	2,4	-1
Secondary building components are too specific (lack of knowledge about installations).	Economic	3	1	-2	3	1	-2	3	3	0	3	3	0	3	3	0	3	0	26	3,0	3,0	3,0	2,2	-4
Amount of actions required (or time needed) to prepare secondary building components for market sale.	Organizational	3	3	0	3	3	0	3	3	0	1	2	1	3	3	0	3	0	27	3,0	3,0	2,6	2,8	1
Lack of knowledge regarding detailed information of secondary building components.	Organizational	3	2	-1	3	2	-1	3	3	0	3	3	0	3	3	0	3	0	28	3,0	3,0	3,0	2,6	-2
Older secondary building components do not meet current demands.	Social	3	3	0	3	3	0	3	3	0	2	2	0	3	3	0	3	0	28	3,0	3,0	2,8	2,8	0
Societal ideas about the pricing of secondary building components.	Social	3	3	0	3	3	0	3	3	0	2	3	1	3	3	0	3	0	29	3,0	3,0	2,8	3,0	1
Uncertainty as to whether secondary building components will be sold.	Economic	3	3	0	2	3	1	3	3	0	3	3	0	3	3	0	3	0	29	3,0	3,0	2,8	3,0	1
Buyers have to pay double taxes on secondary building components.	Regulatory	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	0	30	3,0	3,0	3,0	3,0	0
Laws and regulations e.g. the 'Bouwbesluit'	Regulatory	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	0	30	3,0	3,0	3,0	3,0	0
Lack of subsidies for secondary building components	Regulatory	X	X	0	X	X	0	3	3	0	0	X	0	X	X	0	X	0	ID	ID	ID	0,6	0,6	0

Legend
 Freq. Frequency
 Influ. Influence
 X Known by participant - Data calculated based on average (mean) from other variables
 Unknown by participant - Not calculated due to insufficient data
 Overall impact class = based on classes: low (1), medium (2), and high (3)

Enabling factors	Category	BORK Groep (CBH)			ADEX Groep (CBH)			Hoogeboom			2dehandsbouwmaterialen			INSERT			Total	Overall impact class	Average Freq.	Average Influ.	Total change scores		
		Freq.	Influ.	change scores	Freq.	Influ.	change scores	Freq.	Influ.	change scores	Freq.	Influ.	change scores	Freq.	Influ.	change scores							
New NEN standard for steel (NTA8713).	Regulatory	1	2	1	1	2	1	1	2	1	1	1,25	1	2	1	-1	15,25	2	2,0	1,2	1,7	3	
More space (and time) to store secondary building components at the demolition and disassembling site.	Organizational	1	2	1	1	2	1	1	2	1	2	2	0	2	2	0	17	2	2,0	1,4	2,0	3	
The 'Reuse motivation bringer'.	Organizational	1	1	0	1	2	1	1	3	2	2	2	1	2	3	1	17	2	2,0	1,4	2,2	5	
Increase in interest in secondary building component from the (business) market (due to rising costs of new materials and sustainability goals).	Economic	1	1	0	2	2	0	1	3	2	2	3	0	2	3	1	19	2	2,0	1,6	2,4	3	
Patience to work carefully with secondary building components (for all CBH employees).	Social	2	2	0	2	1	-1	2	2	0	2	2	1	2	2	0	19	2	2,0	2,0	1,8	0	
Motivation to reuse/sell secondary building components (for all CBH employees).	Social	1	3	2	1	3	2	1	3	2	2	3	1	1,25	3	1,75	19,5	2	2,0	1,3	3,0	8,75	
Motivation to streamline the supply processes (for all CBH employees).	Social	2	2	0	1	2	1	2	3	1	2	3	1	1,75	3	1,25	20,5	3	2,0	1,8	2,6	4,25	
Rising costs of new construction materials that balance the price difference between new and reused construction components.	Economic	1	3	2	1	3	2	1	3	2	3	3	-1	2	3	1	22	3	2,0	1,6	3,0	6	
Employing workers with a distance to the labor market to reduce labor costs.	Organizational	2	2	0	3	2	-1	2	2	0	3	2	0	3	1	-2	24	3	3,0	2,6	1,8	-3	
Increasing awareness among various stakeholders about the time required to disassemble and prepare secondary building components for reuse.	Organizational	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	24	3	3,0	2,0	3,0	5	
Laws and regulations, including policies enforcing the implementation of sustainability goals in the construction sector.	Regulatory	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	24	3	3,0	2,0	3,0	5	
Having a recycling option as a backup for recycling leftover building components.	Organizational	3	3	0	1	2	1	3	3	0	3	3	0	2	2	0	25	3	3,0	2,4	2,6	1	
Training and educating specific dismantling teams responsible for all dismantling work (initial training at the hub).	Organizational	1	3	2	3	2	-1	3	3	0	1	3	2	3	3	0	25	3	3,0	2,2	2,8	3	
Earlier involvement of CBHs in the disassembling process.	Economic	3	1	-2	3	1	-2	3	3	0	3	3	-1	3	1	-2	26	3	3,0	3,0	1,8	-7	
Knowledge about which secondary building components are profitable to sell.	Organizational	3	2	-1	3	2	-1	3	2	-1	3	2	0	3	3	0	26	3	3,0	3,0	2,2	-3	
Inventory software.	Organizational	2	3	1	3	3	0	2	3	1	2	3	1	3	3	0	27	3	3,0	2,4	3,0	3	
Materials passports for buildings.	Organizational	3	3	0	3	3	0	3	3	0	2	3	1	2	1	-1	27	3	3,0	2,6	2,6	0	
Network of standard buyers for specific secondary building components that they can also dismantle themselves (collaborations).	Organizational	2	3	1	3	3	0	2	3	1	2	3	1	3	3	0	27	3	3,0	2,4	3,0	3	
Utilizing a digital marketplace (internally or externally organized).	Organizational	3	2	-1	3	2	-1	3	3	0	3	3	0	3	3	0	28	3	3,0	3,0	2,6	-2	
Directing the sale of secondary building components towards both business and private customers, but primarily focusing on one.	Economic	2	3	1	3	3	0	3	3	0	3	3	0	3	3	0	29	3	3,0	2,8	3,0	1	
Effective and open communication among all stakeholders connected to the supply processes.	Economic	3	3	0	3	3	0	3	3	0	2	3	1	3	3	0	29	3	3,0	2,8	3,0	1	
Establishing a large network in advance regarding diverse potential buyers for various secondary building components.	Organizational	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	30	3	3,0	3,0	3,0	0	
Forklift (truck) (alternatively a lifting crane)	Organizational	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	30	3	3,0	3,0	3,0	0	
Small transportation carriers like 'bokken' (or other similar stacking racks, boxes, etc.).	Organizational	3	3	0	3	3	0	3	3	0	3	3	-1	3	3	0	30	3	3,0	3,0	3,0	-1	
Earlier involvement of CBHs in the construction process.	Economic			0	1	1	0	0	1	1	1	2	1		1	1		ID	ID	ID	0,4	1,0	3
Knowledge about the specific requirements of secondary building components from potential buyers.	Organizational	2	2	0	2	2	0	2	2	0		2	0		2	2		ID	ID	ID	1,2	2,0	2

Toestemmingsformulier – Scriptieonderzoek

Datum:

Versie: Standaard interview V1 2023 – Circulaire Bouwhubs

Beste genodigde,

U wordt uitgenodigd om deel te nemen aan een scriptieonderzoek genaamd 'The development of Circular Building Hubs' dat is opgezet n.a.v. een scriptieopdracht voor opleiding MSc Metropolitan Analysis, Design and Engineering (masteropleiding). Dit scriptieonderzoek (onderzoek) wordt uitgevoerd door Quinten Isselman, Masterstudent aan de Technische Universiteit Delft (TUD) en Wageningen University & Research (WUR). Beide universiteiten hebben alleen een begeleidende rol ten aanzien van de inhoudelijke scriptiebegeleiding. De TUD vervult daarnaast ook een rol als beheerder van de lange-termijn opslaglocatie voor de uitgewerkte data.

Het doel van dit onderzoek is om inzicht te verkrijgen in de werking van circulaire bouwhubs in Nederland. U wordt gevraagd om deel te nemen aan een inhoudelijk dataonderzoek in de vorm van een semigestructureerde interview (interview), dat ongeveer 60 tot 90 minuten in beslag zal nemen. De data wordt gebruikt voor analyses door de uitvoerende onderzoeker (Quinten Isselman). De uiteindelijke resultaten van het scriptieonderzoek (Scriptie en bijbehorende presentatie documenten) met geanonimiseerde data, worden gebruikt voor onderwijs doeleinden en worden gepubliceerd op www.openresearch.amsterdam.nl, de WUR en TUD repositories (4TU.ResearchData) en mogelijk worden (delen van) de data stukken gepubliceerd in een wetenschappelijk artikel (het is nog niet bekend welke). Al deze locaties zijn publiekelijk toegankelijk.

Vanuit uw expertise, wordt u gevraagd om diverse vragen (ca. 10-20) in een interview te beantwoorden. Er kan worden gevraagd of het interview **-altijd met uw instemming-** mag worden opgenomen, zodat de resultaten op een later moment beter geanalyseerd en getranscribeerd kunnen worden. De eventuele opnames, zowel audio (b.v. telefoon), als beeld en/of directe transcriptie (b.v. online video-call programma) en dit ingevulde formulier 'Toestemmingsformulier – Scriptieonderzoek, Standaard interview V1 2023' (formulier) worden tijdelijk opgeslagen op een persoonlijk Onedrive account van de uitvoerende onderzoeker. Deze brongegevens worden niet gepubliceerd. Deze brongegevens worden direct na het pseudoanoniem transcriberen overgeplaatst naar een beveiligde opslag van de TUD en definitief vernietigd van de OneDrive van de uitvoerende onderzoeker.

Zoals bij elke (online) of opgenomen activiteit is het risico van een databreuk aanwezig. Wij doen ons best om uw antwoorden vertrouwelijk te houden. De risico's worden geminimaliseerd door de data in alle publicaties en schriften anoniem te vermelden, met hoogstens vermelding van functie en/of de bedrijfs-/ organisatienaam. Wanneer dergelijke naamgeving niet van toepassing is wordt gewerkt met een algemene toepasselijke benaming (bijvoorbeeld; 'Omwonende' of 'Betrokkene binnen het proces'). Verwijzingen naar de resultaten van de geïnterviewde en de persoonlijke namen in de uitgewerkte transcripties van de interviews, worden gedaan met anonieme naamgeving: 'Geïnterviewde [+ bijbehorend volgnummer]'. Deze uitgewerkte en gepseudonimiseerde transcripties, de brongegevens en dit ingevulde formulier worden voor lange termijn opgeslagen op een beveiligde opslaglocatie van de TUD dat beheerd wordt door de verantwoordelijke onderzoeker (M.F.M. (Mart) van Uden). De data is alleen toegankelijk voor de uitvoerende onderzoeker, de verantwoordelijke onderzoeker, de tweede supervisor (Dr.ir. J.N. (Jaco) Quist) en het onderzoeksteam 'TranCiBo' (Het TranCiBo team bestaat uit 8 personen). Het onderzoeksproject van TranCiBo is tot september 2024 in werking. Hierna wordt de opgeslagen data overgedragen en beheerd door Prof.dr.ir. J.W.F (Hans) Wamelink (TUD) op een beveiligde opslaglocatie van de TUD. De uitgewerkte en geanonimiseerde data uit de transcripties kan daarnaast worden gebruikt voor educatie- of onderzoeksdoeleinden. Deze data wordt nog voor onbepaald tijd, maar langer dan 10 jaar, opgeslagen op de '4TU.ResearchData' repository (<https://data.4tu.nl/info/about-4turesearchdata/organisation>).

Uw deelname aan dit interview is volledig vrijwillig, u wordt niet gecompenseerd en u kunt zich elk moment terugtrekken zonder een reden op te geven. Ook bent u bent vrij om vragen niet te beantwoorden.

De uitvoerende onderzoeker is Quinten Isselman (student).

De verantwoordelijke onderzoeker is M.F.M. (Mart) van Uden (TU Delft).

Voor vragen, klachten of andere zaken die betrekking hebben de verzamelde data kan mailcontact worden opgenomen via:

Stuur het ingevulde formulier a.u.b. naar: quintenl.isselman@wur.nl

A: ALGEMENE OVEREENKOMST – ONDERZOEKSDOELEN, TAKEN DEELNEMERS EN VRIJWILLIGE DEELNAME		
1. Ik heb de informatie over het scriptieonderzoek gelezen en begrepen, of deze is aan mij voorgelezen. Ik heb de mogelijkheid gehad om vragen te stellen over het scriptieonderzoek en mijn vragen zijn naar tevredenheid beantwoord.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
2. Ik doe vrijwillig mee aan de semigestructureerd interview (interview), en ik begrijp dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit het interview zonder een reden op te hoeven geven.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
3. Ik begrijp dat mijn deelname aan het interview de volgende punten betekent: er worden diverse inhoudelijke vragen gesteld die betrekking hebben op de werking van circulaire bouwhubs. Met mijn instemming wordt het interview opgenomen (audio opname, video-opname en/of directe transcriptie met b.v. online video-call programma). De antwoorden worden uiteindelijk gepseudonimiseerd en getranscribeerd en worden gebruikt voor analyses voor het scriptieonderzoek.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
4. Ik begrijp dat mijn deelname aan het interview niet wordt gecompenseerd.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
B: MOGELIJKE RISICO'S VAN DEELNAME (INCLUSIEF GEGEVENS BESCHERMING)		
5. Ik begrijp dat mijn deelname aan het interview de volgende risico's met zich meebrengt: er kunnen tijdens het interview (per ongeluk) vanuit mijn perspectief ongewenste vragen worden gesteld, of ongewenste reacties worden gegeven door de uitvoerende onderzoeker. Ik begrijp dat deze risico's worden geminimaliseerd doordat voorafgaand aan het interview een korte voorstelronde wordt gehouden waarbij doel en overwegingen van het interview aan mij worden voorgelegd en ik vragen kan stellen. Ook begrijp ik dat ik ten alle tijden het interview mag stoppen en/of ik mag weigeren antwoord te geven op de gestelde vragen.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
6. Ik begrijp dat mijn deelname betekent dat er persoonlijke identificeerbare informatie en onderzoek data worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden en hier mogelijk publiekelijke of professionele nadelige gevolgen aan zitten.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
7. Ik begrijp dat binnen de Algemene verordening gegevensbescherming (AVG) een deel van deze persoonlijk identificeerbare onderzoek data als gevoelig wordt beschouwd, namelijk religieuze en politieke standpunten en data over criminele activiteiten. Ik begrijp dat dergelijke data binnen het scriptieonderzoek niet van directe waarde zijn en hier ook niet specifiek naar wordt gevraagd.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
8. Ik begrijp dat de volgende stappen worden ondernomen om het risico van een databreuk te minimaliseren, en dat mijn identiteit op de volgende manieren wordt beschermd in het geval van een databreuk: de data wordt in alle publicaties en schriften anoniem vermeldt, met hoogstens vermelding van functie en/of de bedrijfs- organisatiename. Wanneer deze niet van toepassing zijn wordt gewerkt met een algemene toepasselijke benaming (bijvoorbeeld; 'Omwonende' of 'Betrokkene binnen het proces'). Verwijzingen naar de resultaten van geïnterviewden en verwijzingen van namen in de transcripties van de interviews worden geanonimiseerd door het gebruiken van algemene verwijzingen met: 'Geïnterviewde [+ bijbehorend volgnummer]'. Eventuele		

opnames, zowel audio (met b.v. telefoon) als beeld en/of directe-transcriptie (met b.v. online video-call programma) worden tijdelijk opgeslagen op een persoonlijke OneDrive account van de uitvoerende onderzoeker (Quinten Isselman), worden niet gepubliceerd en worden direct na het anoniem transcriberen overgeplaatst naar een beveiligde opslag van de TUD en definitief vernietigd van de persoonlijke OneDrive locatie van de uitvoerende onderzoeker.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
9. Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals bijvoorbeeld persoonlijke voor- en/of achternaam in combinatie met bedrijfsgegevens, niet gedeeld worden buiten het studieteam. Dit team betreft: De uitvoerende onderzoeker, de verantwoordelijke onderzoeker, de tweede supervisor (Dr.ir. J.N. (Jaco) Quist) en het onderzoeksteam 'TranCiBo' (Het TranCiBo team bestaat uit 8 personen).	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
C: ONDERZOEKS PUBLICATIE, VERSPREIDING EN TOEPASSING		
10. Ik begrijp dat na het interview de transcriptie data (een uitgewerkte en gepseudonimiseerde transcriptie van de audio, video en/of directe-transcriptieopnames) gebruikt zal worden voor onderwijsdoeleinden (analyses voor scriptieonderzoek, beoordelingen, eindpresentatie door student, etc.) en de geanonimiseerde eindproducten gepubliceerd worden op www.openresearch.amsterdam.nl, de WUR en TUD repositories en dat mogelijk (delen van) de data stukken worden gepubliceerd in een wetenschapsartikel (het is nog niet bekend welke). Daarbij kan het voorkomen dat mijn antwoorden, ideeën of andere bijdrages anoniem worden geciteerd in producten. Ik begrijp dat al deze locaties publiekelijk toegankelijk zijn.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
11. Ik geef toestemming om mijn antwoorden, ideeën of andere bijdrages anoniem te quoten in resulterende producten.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
12. Ik geef toestemming om mijn functie en/of de bedrijfs- organisatiennaam die ik vertegenwoordig te gebruiken voor quotes in resulterende producten.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>
D: (LANGDURIGE) GEGEVENSOPSLAG, TOEGANG EN HERGEBRUIK		
13. Ik begrijp en geef toestemming om de brongegevens (de audio, video en/of directe-transcriptieopnames), de gepseudonimiseerde transcriptie en dit ingevulde formulier (Toestemmingsformulier – Scriptieonderzoek, Standaard interview V1 2023) die over mij verzameld wordt, gearchiveerd worden op een beveiligde opslaglocatie van de TUD dat beheerd wordt door de verantwoordelijke onderzoeker (M.F.M. (Mart) van Uden). De data alleen toegankelijk is voor de uitvoerende onderzoeker, de verantwoordelijke onderzoeker, de tweede supervisor en het onderzoeksteam 'TranCiBo'. Het onderzoeksproject van TranCiBo nog tot september 2024 in werking is en hierna deze gegevens overgedragen en beheerd worden door Prof.dr.ir. J.W.F (Hans) Wamelink (TUD) op een beveiligde opslagservice van de TUD. Ik begrijp dat ik het recht heb om de data op een later moment te wijzigen of verwijderen tot dat deze is gepubliceerd, de data alleen wordt gebruikt voor educatie- of onderzoeksdoeleinden en nog voor onbepaald tijd, maar voor minimaal 10 jaar, worden opgeslagen.	JA <input type="checkbox"/>	NEE <input type="checkbox"/>

Handtekeningen

Naam deelnemer	<input type="text"/>
Handtekening	<input type="text"/>
Datum	<input type="text"/>
Heeft u nog opmerkingen?	<input type="text"/>

Ik, **Quinten Isselman**, verklaar dat ik de informatie en het instemmingsformulier correct aan de potentiële deelnemer heb voorgelezen en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Naam onderzoeker	<i>Quinten Isselman</i>
Handtekening	<input type="text"/>
Datum	<input type="text"/>

Uitvoerende onderzoeker:
Verantwoordelijke onderzoeker:

Quinten Isselman (Student, TUD & WUR)
M.F.M. (Mart) van Uden TU Delft, supervisieteam).

Contact kan opgenomen worden via:

M.F.M.VanUden@tudelft.nl.

Stuur het ingevulde formulier a.u.b. naar: quinten1.isselman@wur.nl



Klik hier! om het compleet ingevulde formulier automatisch te retourneren **via E-mail**

Klik hier! Om het formulier te printen



Appendix G - Ethical clearance Committee TUD

Date 13-Jun-2023

Contact person Grace van Arkel, Policy Advisor
Academic Integrity

E-mail E.G.vanArkel@tudelft.nl



Human Research Ethics
Committee TU Delft
(<http://hrec.tudelft.nl>)

Visiting address

Jaffalaan 5 (building 31)
2628 BX Delft

Postal address

P.O. Box 5015 2600 GA Delft
The Netherlands

Ethics Approval Application: The development of Circular Building Hubs
Applicant: Isselman, Quinten

Dear Quinten Isselman,

It is a pleasure to inform you that your application mentioned above has been approved.

Thanks very much for your submission to the HREC which has been approved.

Good luck with your research!

Sincerely,

Dr. Ir. U. Pesch
Chair HREC
Faculty of Technology, Policy and Management

Appendix H - Interview transcripts (External)

Appendix I - Focus Group Discussion (External)

Appendix J – Observation field notes & photo's (External)