Linköping University | Department of Management and Engineering
Master's thesis, 30 credits| Design and Product Development - Management
Spring 2023| LIU-IEI-TEK-A--23/04640--SE

Towards Circular Business Models in Swedish Rock and Soil Material Management

– An ecosystem-level exploration

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Acknowledgements

I want to thank all the respondents who participated in the interviews and shared valuable experiences and competencies within their fields. Moreover, I am thankful for the great support I have received from Ecoloop. I would like to give an extra thanks to Kristina Lundberg who has guided me throughout the process and taken the time to explain how the material management industry works. Lastly, I would like to thank my opponent and supervisor for their feedback and guidance throughout the thesis work.

Stockholm, August 2023

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Abstract

Title: Towards Circular Business Models in Swedish Rock and Soil Material Management - *An ecosystem-level exploration*
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Background: The rapid growth of Swedish metropolitan regions, has led to increased demand for rock and soil materials for building construction and infrastructural work. Sweden's rock and soil material management industry extracts over 100 million tons of aggregate per year, while only succeeding in recycling 1% of it. Moreover, the industry generates excavated material, resulting in even more waste. This linear flow of materials has become unsustainable, prompting a need for more efficient resource management through circular solutions where the value is decoupled from resource consumption and environmental impact. To achieve a circular economy, companies need to innovate and rethink their business models. The value network becomes crucial in managing relationships with various actors to address the risks and responsibilities associated with the circular transition. By considering the value network dimension, the business model concept surpasses the firm boundaries and takes a holistic ecosystem-level perspective, which could facilitate a shift towards circular business models.

Purpose: The purpose is to explore the possibilities of moving towards more circular business models within Swedish rock and soil material management with an ecosystem-level perspective.

Methodology: This study employs a qualitative case study as a research design to explore the opportunities to transition to circular business models. The data is collected through seven interviews with an abductive approach to allow an iterative process and explore themes and patterns of the industry. The respondents represent actors from all different business scopes of Swedish material management which are identified from a pre-study.

Conclusions: The material management industry in Sweden comprises diverse business models with varying use of circular strategies within the value capturing and value propositions. Despite circular strategies being established in the industry, their expansion is hindered by certain factors, resulting in a low recycling percentage. For instance, the influence of specific business relations on actors' business models impacts circular strategies, limiting their adoption. However, the study highlights that envisioning circularity often involves an ecosystem-level perspective, emphasizing collaboration between projects and value network members as a solution. Consequently, the ecosystem-level perspective can both limit and enhance circular strategies based on how relations with actors are managed. To bridge the gap between limiting and enhancing value networks, industry members need to actively manage relations with various actors, fostering collaboration and recognizing the broader ecosystem. Embracing these approaches can facilitate the adoption of more circular strategies within the material management industry in Sweden.

Keywords: *Business models, circular business models, value dimensions, value proposition, value capturing, value network, ecosystem-level, circular strategies*

List of abbreviations

EBSCO	Elton B. Stephens Company
GDP	Gross Domestic Product
SGU	Swedish Geological Survey
SLL	Stockholm County Council
UEPG	European aggregates Industry
UNEP	UN Environment programme

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1 Introduction

In this chapter, the background and the problematization of the studied case is presented, as well as the research questions and the purpose they are responding to. Furthermore, the delimitations of the thesis are clarified.

1.1 Background

Along with a global growing population follows an increased consumption of material resources (UNEP, 2011). Not only the consumption of resources but also the linear process of how the resources are managed entails a negative environmental effect (Magnusson, et al., 2019). When extracting virgin materials, threats are posed to the ecosystem and to the current and future generations' health. The threat is especially large in urban areas due to growing urbanization. Today, 80% of global CO2 emissions are emitted from urban areas. Additionally, urban areas stand for 80% of global energy use (Magnusson, et al., 2015). Consequently, resource efficiency within cities has become especially important due to the consequences of growing urbanization.

As the cities are growing, the demand for construction- and infrastructural work increases, and thereby aggregate material. The material is used in construction as filling, as a foundation in road construction, and as a main component in concrete and asphalt (Lundberg, et al., 2022). Each year around 100 million tons of aggregate material are extracted from quarries in Sweden (UEPG, 2019). Furthermore, the construction- and infrastructural work does, in turn, excavate quantities of materials on the construction sites for preparation of the ground. The excavated materials that arise on construction sites often become excess materials since they do not meet the set quality criteria for aggregate (Lundberg, et al., 2020). Consequently, this type of material is not used at the construction site and is therefore transported away, most often to a landfill. Altogether, this management of material results in a linear process of finite resources.

Moreover, moving aggregate from suppliers to construction sites, as well as excavated materials from construction sites to landfills or recycling facilities, results in a prominent level of heavy transport. Additionally, the retour-transports become ineffective since almost half of the trucks drive empty when leaving the landfill (Lundberg, et al., 2020). Altogether, the transport of rock and material constitutes 30% of the Co2 emissions from heavy transport in the Stockholm area. Consequently, the industry's linear flow of material does not only cause natural resource consumption, but also traffic, wear on the roads, and negative environmental effects from transport (Mácsik, 2018). Altogether, the profits of starting to use resource-efficient materials could be several, such as saving finite natural resources and energy from mining, but also from decreased transport and thereby decreased emissions (Mácsik, et al., 2020).

The linear process of resources has constituted a principle for the industries' business models since the industrial revolution (Nguyen, et al., 2014). These types of linear business models imply a so-called 'take-make-waste' way of thinking, which Ellen MacArthur (2023) describes as when we take resources from the ground, make products from them, and eventually throw

them away as waste. Comparably, the material management industry's so-called quarry-construct-landfill process (Mácsik, et al., 2020), lays the ground for the industry's linear business models.

A linear business model is structured in a way where the resource consumption is coupled to value since that is what creates the value (Ellen MacArthur Foundation, 2023). By decoupling value creation from resource consumption, a transition from a linear to a circular business model could be done (MacArthur, et al., 2015; De Angelis, 2018). In that way, a high value in the business model could still be contained without requiring more resources. Additionally, the growth of value is often associated with environmental pressure (Ekins, 1999). Therefore, value creation must also be decoupled from negative environmental impacts (UNEP, 2011).

Creating value is a commonly found theme in literature when defining the business model as a concept (Minerbo & Brito, 2022; Osterwalder & Pigneur, 2010; Lüdeke-Freund, et al., 2018; Richardson, 2005). Richardson (2005) presents a framework of three different value dimensions: value proposition, value creation, and value capture. The different dimensions refer to what the firm will deliver to its customers, how value is created and delivered to the customers, and lastly, a firm's cost and revenue structure and flow (Richardson, 2005).

To enable transit from a linear to a circular business model and decouple resource consumption and environmental impact from value creation, companies are required to innovate and rethink their business models (Lüdeke-Freund, et al., 2018). However, a transition to a circular economy also requires an integrated approach that surpasses the focal firm's boundaries (Nußholz, 2018). The changes that a circular transition implies must change at an ecosystem level, where several firms work in a network towards a common goal (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021). Therefore, the concept of business models must surpass the focal firm's boundaries and be placed closer to the firm's network (Kanda, et al., 2021). When the business model is applied closer to the network, a new value dimension is added to the concept of business models - the value network (Kanda, et al., 2021). Since the circular economy entails increased risks and responsibilities the relationship with various actors within the industry's network becomes important to manage (Parida, et al., 2019). Moreover, the value network is an important dimension as the circular transition requires the firm to acknowledge more diverse actors and stakeholders for which the firm can create value (Ranta, et al., 2020).

1.2 Problematization

The Swedish metropolitan regions are some of Europe's most growing areas (SLL, 2017). Only in Stockholm, the population is expected to grow by half a million by 2030 (SGU, 2021). Moreover, the management of rock and soil materials constitutes up to 10% of the construction costs (Ecoloop, 2020). Since the construction- and infrastructural work are expected to meet the growth within urban areas, it will imply large costs for the industry (Mácsik, 2018). Consequently, the linear flow of materials within the industry has started to be seen as economically unsustainable and thus, created a demand for more efficient resource management through circular solutions (SBMI, 2023).

The demand for aggregate in Sweden from now until 2030 is calculated to be around 19 million tons per year (SLL, 2017). Furthermore, the amount of excavated materials is expected to exceed 19 million tons per year (SGU, 2021). Accordingly, the aggregate demand could be covered by the amount of material that is excavated on the construction sites. However, much of the excavated material becomes waste today and is, therefore, neither reused nor recycled (Naturvårdsverket, 2016; UEPG, 2019; Optimass, n.d.).

There are several examples of actors that recycle excavated materials today, using established techniques such as wet sight and other sorting methods to refine the materials to meet quality standards. However, large quantities of the excavated materials are often prevented from being refined and sold as new products by regulations since it is often classified as waste (Naturvårdsverket, 2016). As a result, building contractors become encouraged to use extracted aggregate and leave excavated materials at waste management rather than for recycling (Prenkert, 2022). Moreover, Mácsik et al. (2020) identify a low demand from building contractors for recycled material due to the low trust in its environmental engineering and technical character. Another challenge of recycling is that the recycling actors are often locally bound to one geographical area, therefore causing long transports of materials. Furthermore, it requires several permissions to build a recycling facility which complicates and prolongs the process. Accordingly, only a fraction as small as 1% of all sold aggregate in Sweden is recycled (UEPG, 2019).

The construction and infrastructural work industry involves several different actors with different functions through the material flow. Excavation, construction, landfilling, recycling, and transport are often all performed by different actors (Mácsik, et al., 2020). Consequently, there are different interests within the industry and therefore also business models that differ from each other. Circular management of the material will therefore require changes in several actors' businesses (Mácsik, et al., 2020). Although there are actors including circular activities within their business model, there is still a low percentage of recycled aggregate used in the industry. Therefore, it is of interest to explore if the percentage of recycled material could increase by moving the concept of circular business models outside the firm’s boundaries to an ecosystem level.

Altogether, there are numerous technical and legal reasons identified why the level of recycled material is low within the industry (Naturvårdsverket, 2016; Mácsik, et al., 2020). However, there is less research done on the business models’ impact on the industry’s recycling possibilities, and therefore of interest to explore. Furthermore, the material management industry includes several actors, where the different business models impact each other. It is therefore of interest to explore if the concept of business model should have an ecosystem-level perspective when moving towards more circular business models.

1.3 Purpose and Research Questions

The purpose is to explore the possibilities of moving towards more circular business models within Swedish rock and soil material management with an ecosystem-level perspective. Based on this purpose the following research questions are developed:

- Which circular strategies are used within the current business models?
- How does the ecosystem-level perspective enhance respectively limit the transition towards more circular business models?

Based on these two questions the results seek to provide an outlook of the industry's situation today and to explore whether the move towards more circular business models is enhanced or limited if applying an ecosystem-level perspective on the concept of business models. Moreover, the results of the thesis aim to provide practical insights from the industry and how different actors can work together to a circular transition.

1.4 Delimitations

- The studied material flow concerns extracted rock and soil from quarries and excavated materials from construction sites.
- Several of the companies within the case study do have business models that include propositions beyond rock and soil material management. However, the parts of the business models that do not regard rock and soil material management are not taken into consideration when examining the business models or the circular economy.

2 Theoretical framework

In the following chapter, relevant theoretical areas of the thesis's subject are presented. The theory is described to contribute to the understanding of the thesis and its analysis of empirics. The framework regards the concept of both business models and circular economy to further explain the concept of circular business models and how such a transition is achieved through innovation.

2.1 Business models

The discussion around the business model concept emerged in the 1990s and has since then not reached a settled definition. It is supposed that the discussion of business models emerged with the advent of the Internet and the expanding industries dependent on postindustrial technologies (Zott, et al., 2011). The concept has since then taken place in various contexts and comes from several diverse disciplines (Al-Debei & Avison, 2010). Even though the business model concept does not have one settled definition in literature (Zott, et al., 2011), there are identified themes and dimensions of it.

A business model can focus on the different activities implemented in the business (George & Bock, 2011). From a more holistic perspective, on a so-called system-level concept, the different activities of a business are also accompanied by how they are done within the business (Zott, et al., 2011). The activities could be referred to as value mechanisms (George & Bock, 2011), which implies the activities that create value in the business. An activity that creates value is defined by the uniqueness of how the business performs the activity compared to other businesses (Shafer, et al., 2005).

However, not only the creation of value but also the capturing of the value should be included as a part of completing a business model (Zott, et al., 2011; Shafer, et al., 2005). The value capturing responds to the profit that is generated from the created value proposition (Shafer, et al., 2005). Furthermore, the capturing could be defined as the cost structure and revenue flows of the business (De Angelis, 2018). If the business is not able to capture economic returns that correspond to the value they create, the model is not complete and therefore value creation and value capturing are the two categories of a business model that decide the business's viability (Shafer, et al., 2005).

Further, in terms of value, Richardson (2005) presents a business model framework that aims to guide the execution of a strategy. Based on the logic of strategic thinking of value, Richardson (2005) has developed a business model framework, that adds a third value dimension. Besides value capturing and creation the value proposition is included. The value proposition includes both the offering, the target customers, and the basic strategy to achieve it (Richardson, 2005; Osterwalder, 2004). A business model requires a balance between the value that is proposed to the customer and the value that is captured by the provider (Teece & Linden, 2017). All three dimensions aim to gain and sustain a competitive advantage by answering the questions: *What value is proposed and to whom? How is value created and delivered?* respectively *How is value captured?*

However, the perspective on achieving a competitive advantage has started to move from firm-level to ecosystem-level (Teece & Linden, 2017; Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021). Therefore, when considering the concept of business models, it is important to see it from an ecosystem-level perspective. To move the business model concept outside the firm's boundaries, the business model concept requires new value dimensions besides the value capturing and value proposition to apply to the business model concept (Kanda, et al., 2021). Kanda et al. (2021) presents the value network as an additional value dimension. All three value dimensions are presented further below.

2.1.1 Value proposition and delivery

The distinguishing of value proposition and value creation can sometimes be indistinct and therefore viewed as the same process (Minerbo & Brito, 2022). However, the value proposition aims more towards the business proposition, and how it is developed in relation to the customer's needs and demand. For instance, the value proposition part of a business model develops a customer requirement specification (Minerbo & Brito, 2022; Teece & Linden, 2017). Meanwhile, a firm's value delivery refers to how the proposed value is delivered to the customers (Richardson, 2005; Osterwalder & Pigneur, 2010; Nußholz, 2018). More particularly, it examines with what key resources and key activities the firm possesses, could the value be delivered. (Osterwalder & Pigneur, 2010). In other terms, a firm's value proposition refers to the offered products and/or services, while value delivery corresponds to the firm's system of delivering the proposition to its customers (Guldman, 2018), which can include both channels and key partners (Osterwalder & Pigneur, 2010). This thesis focuses on what product or service is offered rather than on how it is delivered, and therefore the delivery is not included

2.1.2 Value capturing

Value capturing is closely related to the value proposition and delivery since it defines how a company generates revenues out of what has been proposed and delivered (Shafer, et al., 2005; Sjödin, et al., 2019). Therefore, both the value proposition and the value capture are seen as core in a business model to gain a competitive advantage (Minerbo, et al., 2021). The revenue stream consists of several elements such as pricing logic, channels, and customer interactions. Likewise, the cost structure within a business model includes several elements, such as core assets and capabilities (Teece & Linden, 2017).

There are three distinguished approaches to increasing the value capture – by increasing prices, volume, and collaboration (Minerbo, et al., 2021). The first refers to holding a larger share of the same amount of created value. Secondly, customers can increase the value depending on the price and performance. Lastly, by collaborating with the customer, value-added services could be charged.

Furthermore, the captured value allows new investments in resources, technology, and business relationships, which leads to more value creation (Ellegaard, et al., 2014). Altogether, value capturing is considered a central element in the business model since it represents the firm's share of the created value (Teece & Linden, 2017).

2.1.3 *Value network – from an Ecosystem-level perspective*

The ecosystems often consist of one or two firms providing a platform, on which other members provide complementary goods. For the ecosystem to function, interdependencies between the members need to occur by shared purpose and intentions (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021). Moreover, the value captured within the members' business models must reach a balance in both profits for the focal firms as well as profitability for the ecosystem (Teece & Linden, 2017). Consequently, an ecosystem implies that the concept of business models surpasses the focal firm's boundaries and is placed closer to the firm's network.

To enable movement outside the firm's boundaries, the business model concept requires new value dimensions to apply to the concept (Kanda, et al., 2021). An example of a new dimension is the value network, which implies a set of actors creating economic, social, and environmental value (Kanda, et al., 2021). The set of actors consists of interconnected firms and stakeholders who link that work together in a complementary manner, which creates value (Allee, 2000). The defining characteristic of these networks lies in the interdependence between different actors. When something is provided through a network, it requires the utilization of multiple network firms (Leviäkangas & Öörni, 2020). At the same time as the actors are working independently, they must function collaboratively. Moreover, an actor's relationships with other network participants are crucial for their competitive positioning (Peppard & Rylander, 2006). Moreover, the relationships within the value network are not only crucial for the focal actor's competitiveness but for the whole industry's development (Aarikka-Stenroos, et al., 2021). However, an existing value network will in general change in the future and should therefore not be assumed to be persistent (Shafer, et al., 2005).

The ecosystem-level perspective could also be applied when innovating a business model. A business model innovation should focus on changing systems and the way of doing business rather than developing new individual technologies (Bocken, et al., 2014). Moreover, Bocken et al. (2014) state that value is no longer created by firms working separately, but by acting together with external parties through formal or informal alliances. Consequently, by applying an ecosystem-level perspective when innovating business models, the value will be generated across the network of actors (Aarikka-Stenroos, et al., 2021). Moreover, altering elements in an individual business model could change the connections to external stakeholders within the value network (Nußholz, 2018), and therefore it is important to consider the value network even from a firm-level perspective.

2.2 Circular Economy and Circular business models

The definition of circular economy differs in literature (Kircherr, et al., 2017). Although, it is an emerging topic in publications, companies, and regions (Geissdoerfer, et al., 2017).
One established definition of circular economy is the one by Macarthur et. al (2015) which reads "An economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times". Furthermore, it thrives

to oppose the linear model of "take, make, waste" by increased resource efficiency and waste minimization (Aarikka-Stenroos, et al., 2021).

Furthermore, it is stated that environmental change will only be done in line with economic and social changes (Bocken, et al., 2014). Therefore, a circular business model requires a focus that goes beyond the economic dimension and could include both an environmental and a social dimension (Joyce & Paquin, 2016). Moreover, as the circular economy refers to closing loops (Ellen MacArthur Foundation, 2023) it could also include closing loops in industrial ecosystems (Stahel, 2016). Furthermore, the closed loop of material and energy that a circular economy thrives to (Ellen MacArthur Foundation, 2023) implies exchanges between different actors (Kanda, et al., 2021). Therefore, it is important to consider the ecosystem which the value networks operate within when envisioning circularity (Ranta, et al., 2020)

A Circular Business Model proposes and captures value similarly to how a business model is described to do. However, the focus is switched from a single-use cycle to several lifecycles, by the implementation of circular strategies (Nußholz, 2018). For instance, the *value proposition* could be re-defined during the product's lifecycle. Moreover, *value capturing* could entail that revenue streams are captured several times throughout the lifecycle. To capture value several times could result in some life cycles that will result in costs, for instance when collecting material. Although, other life cycles will reduce the costs, namely when substituting the virgin material by reintegrating secondary material (Nußholz, 2018).

It is stated no business model could be fully circular, yet each business model is both linear and circular to a certain extent (Lewandovski, 2016). To what extent a business model is circular could be decided through the use of circular strategies within the business model (Bocken, et al., 2016). Below, different circular business model strategies are presented.

2.2.1 Circular business model strategies

To achieve the minimization of resources and waste, material and energy loops should be slowing, closing, and narrowing (Geissdoerfer, et al., 2017). By slowing, closing, and narrowing the loops, Geissdoerfer et al. (2017) state that resource input and waste, emission, and energy leakage will be minimized. To achieve the loops that are slowed, closed, and narrowed different processes such as long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling should be used. More precisely the 'slowing' of the circle is achieved through the reuse, repair, or remanufacturing or a combination of these to create a prolonged use of goods over time (Bocken, et al., 2016). Furthermore, 'closing' refers to closing the loop between post-use and production which is achieved by recycling materials. Lastly, 'narrowing' refers to being resource efficient by using fewer resources per product.

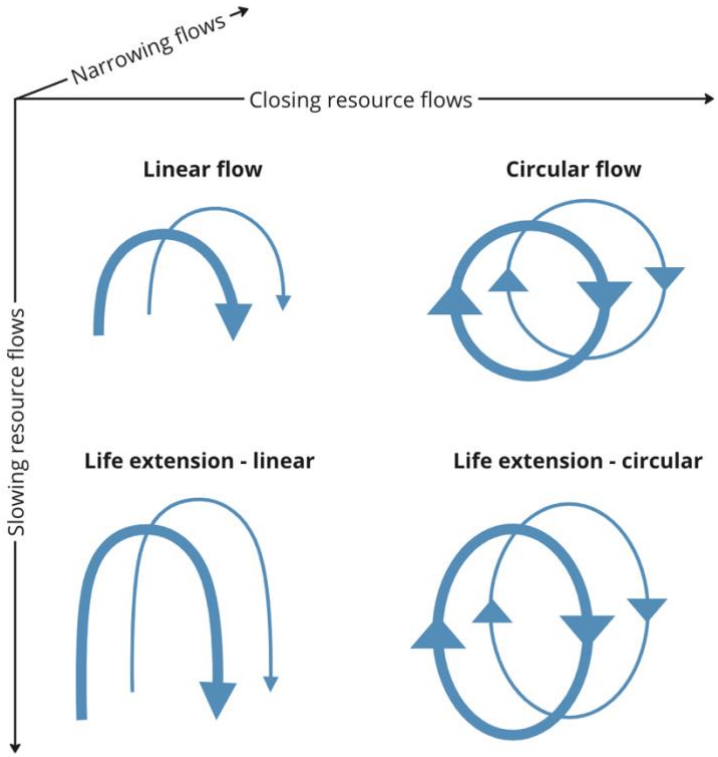

Figure 1 Slowing, closing, and narrowing resource flows. Adapted from Bocken et al. (2016)

The three circular strategies of slowing, closing, and narrowing the resource flows are illustrated by three different dimensions in Figure 1. The figure shows how the resource flow appears when applying the different strategies of slowing, closing, and narrowing, either separately or combined.

The resource flow is also presented by Ellen MacArthur Foundation (2019), in the Technical Circular Economy System Diagram which shows the continuous flow of materials and energy in a Circular Economy. The diagram includes different processes at the end-of-life stage for products that use finite materials, so-called end-of-life processes. The processes within the system diagram are prolonging, reusing, remanufacturing, and recycling and are illustrated in Figure 2.

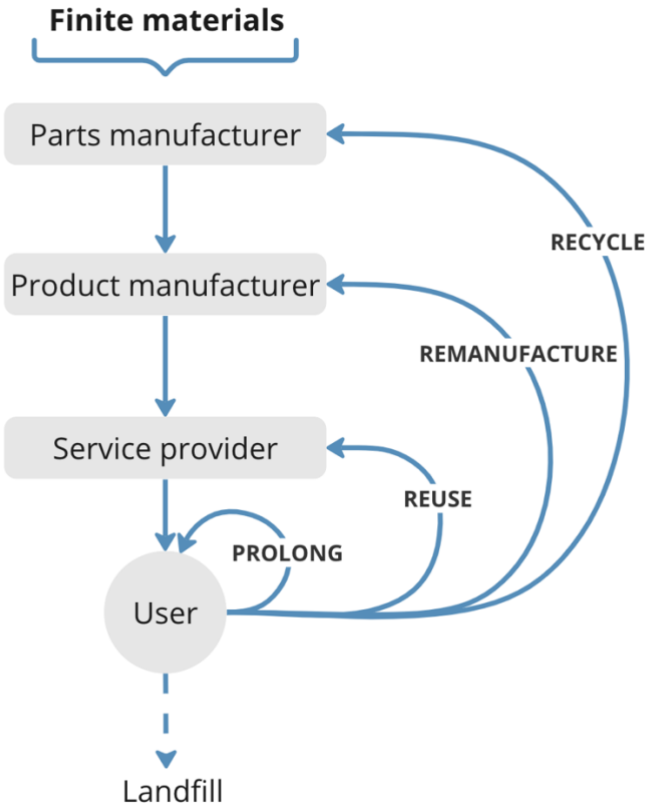

Figure 2 The Technical Circular Economy System Diagram. Adapted from the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2019).

The different sizes of the loops imply that different amounts of value of energy and material is entailed within the loop - the larger loop the less value is entailed and vice versa. The different processes maintain different amounts of embedded value in the product depending on how intact the product or material is kept. For instance, the end-of-life process 'Prolong' constitutes the smallest loop since the product is kept intact and therefore entails the highest value of energy and material. Contrariwise 'recycling' constitutes the largest loop since the product is reduced to its basic material level and therefore more value of energy and material is lost, than in the loops closer to the center of the diagram. Both the processes prolong, and recycling could be exemplified by cleaning a glass bottle and reusing it directly, which is both cheaper and faster, and therefore contains a higher value, than if the glass were recycled and a new bottle was made from the mineral (Stahel, 2016). Lastly, the diagram illustrates the arrow to landfill which implies that neither the value of the material nor the energy is kept (Ellen MacArthur Foundation, 2019).

Altogether the different end-of-life processes aim to reduce primary production on finite resources and minimize waste (Ellen MacArthur Foundation, 2023) by keeping energy and material at its highest value. Similarly, the slowing closing and narrowing of loops aim to minimize resource input and waste, emission, and energy leakage. However, the two different frameworks differ as the slowing of loops, which refers to prolonging the product life, does not solely respond to the end-of-life process 'prolong' but also to the reuse and remanufacturing processes. Moreover, closing the loops is achieved by recycling, while the Technical Circular

Economy System Diagram refers to all the end-of-life processes as closed loops. Lastly, 'narrowing' does not per definition imply that a loop exists since it can be applied in a linear economy as well (Bocken, et al., 2016). However, it aims for the same result as 'slowing' and 'closing' loops as well as the end-of-life process – to minimize the resources within the system.

Moreover, 'narrowing' does not address the dimension of time such as 'slowing' does. Consequently, if the 'narrowing' is considered without 'slowing', the speed of the resource flow could increase and thereby also the materials in the resource flow (Bocken, et al., 2016). Increased resource use is a risk when gaining resource efficiency by implementing a circular strategy (Zink & Geyer, 2017). In a case where a circular strategy has the opposite effect, a so-called rebound effect has appeared (Zink & Geyer, 2017). The time dimension is neither considered within the different end-of-life processes, which creates a risk for the rebound effect to occur when implementing the end-of-life processes. The so-called rebound effect could also appear when the secondary products do not substitute for the primary ones or when prices reduce and therefore lead to increased consumption (Zink & Geyer, 2017).

However, products or materials must still generate revenue even though circular strategies are implemented. Stahel (2016) states that making economic wealth by creating long-lasting products or materials, is the opposite of what has been taught in economics schools regarding linear economy before. In other words, the shift to a circular economy implies that economic growth is decoupled from the use of finite resources (UNEP, 2011). Altogether, the different circular processes aim to counteract the linear business model, where the embedded values are lost after a single-use phase (Nußholz, 2018).

2.2.2 Decoupling

A linear economy is structured in a way where resource consumption creates the value (Ellen MacArthur Foundation, 2023), in other terms, the linear economy is coupled with resource consumption. Therefore, by decoupling value creation from resource consumption, a transition from a linear to a circular economy could be achieved (MacArthur, et al., 2015). Furthermore, a circular economy aims to reduce waste generation (Aarikka-Stenroos, et al., 2021) and should therefore be decoupled with economic growth (Sjöström & Östblom, 2010).

There are various aspects of decoupling. The various aspects imply decoupling from economic activity (GDP), which is illustrated in Figure 3. One aspect of decoupling refers to the decoupling of the use of material resources from economic activity (GDP). UNEP (2011) defines material resources as "natural assets that are deliberately extracted and modified by human activity, for their utility to create economic value". Another aspect of decoupling refers to when the environmental impact is decoupled from the economic activity (UNEP, 2011; Kjaer, et al., 2018). As a result, the two distinct aspects of decoupling could be defined as "using fewer resources per unit of economic output" respectively "reducing the environmental impact of any economic activities that are undertaken (UNEP, 2011). Accordingly, coupling occurs when the growth or material resource use or environmental impact is constant with, or higher than, the economic growth (UNEP, 2011).

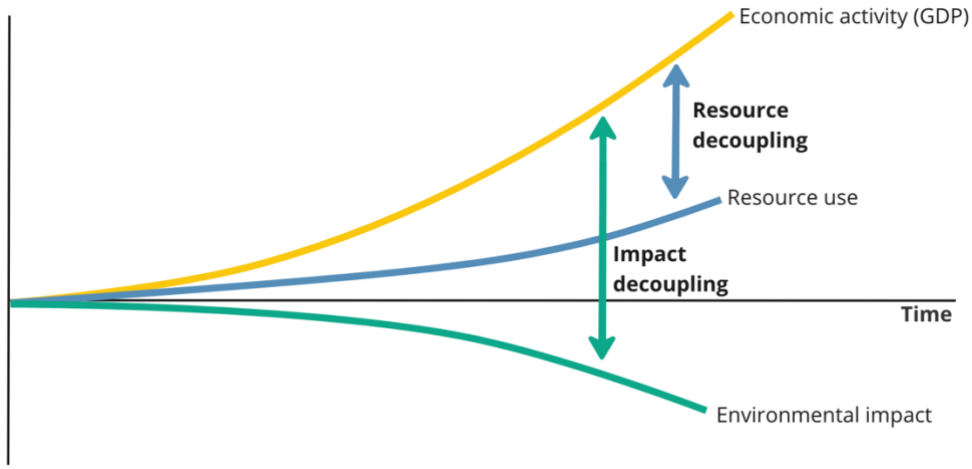

Figure 3 Two different aspects of decoupling. Adapted from UNEP (2011)

Moreover, the generation of waste is often connected to economic growth (Sjöström & Östblom, 2010). Accordingly, a circular economy does also decouple waste from economic growth (Sjöström & Östblom, 2010).

2.2.3 Ecosystem-level perspective: Circular business models

Several sources state that a transition to a circular economy requires a holistic approach that goes beyond the focal firm's boundaries (Nußholz, 2018; Bocken, et al., 2014; Aarikka-Stenroos, et al., 2021). It requires close work with the ecosystem partners to imply circular activities in the firm and engage them in the activities. For instance, it could require the other members to take on new roles and responsibilities and thereby also to undergo a change in their business models (Parida, et al., 2019; Nußholz, 2017). Moreover, activities based on a circular economy do not only surpass a firm's boundaries but can also cut across several sectors and markets (Kanda, et al., 2021).

A circular transition strives to close the loops of material and energy which respond to how a natural ecosystem works (Kanda, et al., 2021). To enable closing the loops, exchanges of material and energy between different actors are required. The exchange often implies that excess material and energy could be offered to other actors within the ecosystem (Kanda, et al., 2021).. Consequently, when closing loops of material and energy within the ecosystem, new cost structures and revenue flows are generated. Moreover, the exchange of excess material and energy often results in waste management costs that could be avoided (Kanda, et al., 2021). Therefore, the changes that a circular transition implies, such as resource efficiency, flows of material, energy, and value must change at a system level (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021)

Another reason for applying the ecosystem-level perspective in a circular transition is the increased risks and responsibilities it entails. Therefore, it is important to manage the relationships and extend the interactions with various stakeholders (Parida, et al., 2019). Additionally, the relationship within the network is important to manage since a firm must

entice its members within the ecosystem to make a circular change in their business models as well (Parida, et al., 2019). A leader must therefore view the health of the network and its members, in which the focal firm occurs, as important as their firm (Peppard & Rylander, 2006).

Altogether, the circular economy shapes the logic av value creation (Nußholz, 2018). However, not only within the focal firm but also in the value network (Aarikka-Stenroos, et al., 2021). As a result, the firm needs to acknowledge more and diverse actors and stakeholders for which the firm creates value (Ranta, et al., 2020).

2.3 Model of analysis

This thesis uses both the concept of business models and circular economy, to explore the circular opportunities, which are illustrated in Figure 4. None of the concepts of business models nor circular economy has a settled definition in literature (Kircherr, et al., 2017; Zott, et al., 2011). Moreover, both concepts take place in various contexts (Al-Debei & Avison, 2010; Geissdoerfer, et al., 2017). Regarding both concepts' wide definitions and contexts, this thesis will delimit the concepts and only analyze particular and the most relevant definitions of them.

Although the concept of the circular economy takes place in various contexts, it has a more commonly found theme in the context of materials, where it often refers to decoupling (UNEP, 2011; Ellen MacArthur Foundation, 2023; Mazzanti & Zoboli, 2008). Therefore, this thesis analyses the circular economy through the theory of decoupling. Furthermore, when concerning finite materials, the circular economy often refers to the Technical Circular Economy System Diagram by Ellen MacArthur Foundation (2019), which refers to keeping material at its highest value. Moreover, the circular economy is analyzed through the circular strategies of closing, slowing, and narrowing loops, which according to Geissdoerfer et al. (2017) aim to decrease resource input, waste, emissions, and energy leakages, which also the material management industry strives for.

Regarding the concept of business models, different value dimensions are often used in the context of transitions to circular business models (De Angelis, 2018; Nußholz, 2018). Therefore, the theoretical framework includes three different value dimensions. The first two, *value proposition* and *value capturing,* are developed by Richardson (2005) and illustrated within the business model value dimension in Figure 4. The two value dimensions, together with the circular strategies are used to analyze the first research question - *Which circular strategies are used within the current business models?*

The third value dimension, *the value network*, refers to the relationships with other actors within the value network. This value dimension is applied when analyzing the concept of business models from an ecosystem-level perspective (Kanda, et al., 2021), see Figure 4. The third value dimension, *value network, is* used to analyze the second research question - *How does the ecosystem-level perspective enhance respectively limit the transition towards more circular business models?* The second research question is analyzed after the first research question

since the result of the first research question sets the basis for analyzing a further move towards a circular business model.

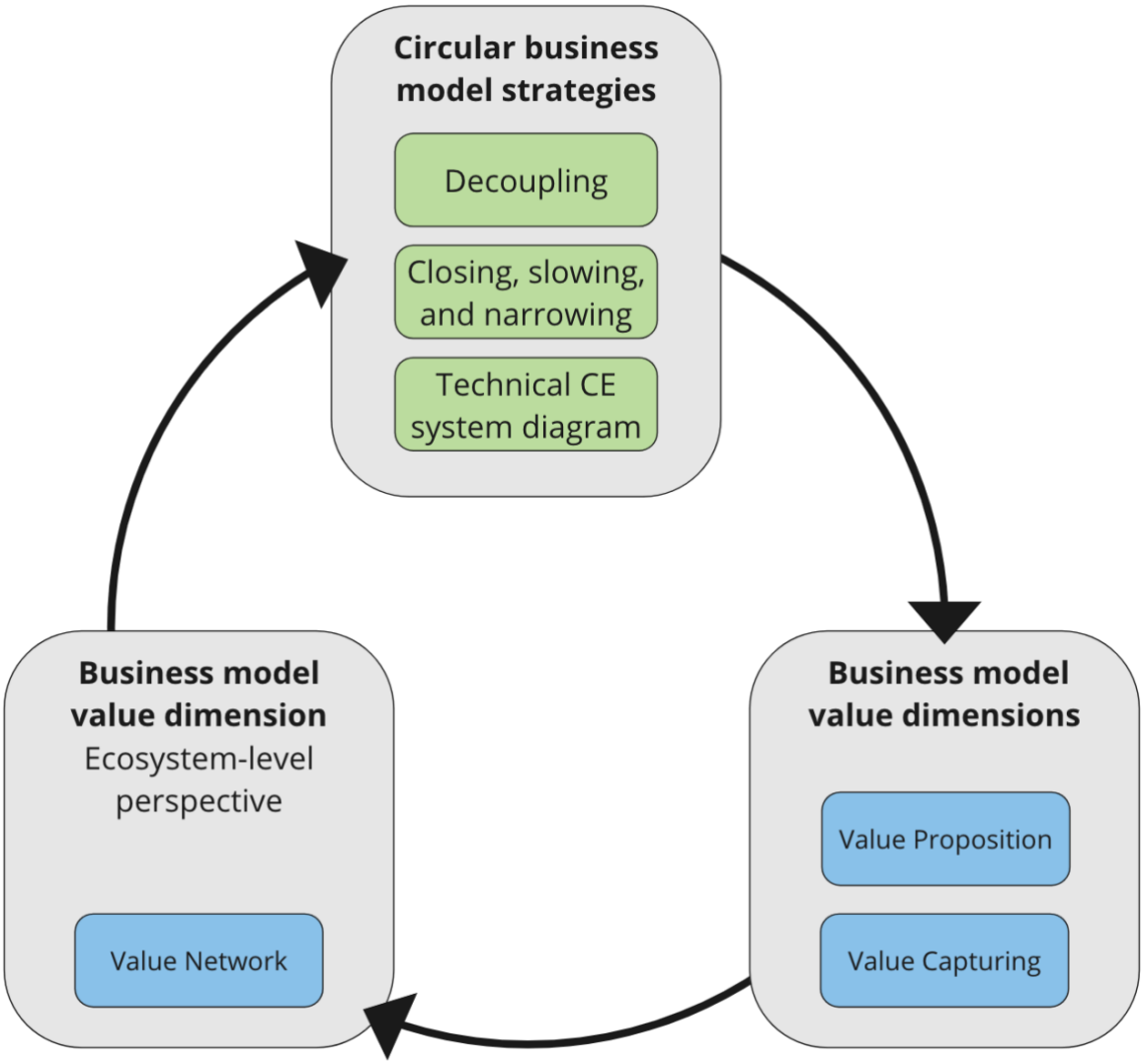

Figure 4 Model of Analysis

3 Method

The following chapter presents available research methods and explains the theory of the chosen ones. Moreover, the choice of the methods used is motivated. The chapter also describes the workflow and the implementation of research methods.

3.1 Research approach

Two different strategies, inductive and deductive, are often used to discuss the relationship between the theory and the empirical data. The inductive strategy entails a process where research observations and findings lead to a theory while the deductive strategy reverses the connection (Bell, et al., 2022). However, the two strategies do not exclude each other, which therefore makes it beneficial to use them as tendencies rather than clear distinctions from each other. Furthermore, business research processes are often iterative, implying that a one-way process from theory to findings or vice versa is difficult to perform.

To avoid the distinction and a one-way process, a third strategy is commonly used in business research, namely the abductive strategy. This strategy entails a dialogical process between the theory and empirical finding (Bell, et al., 2022). Since both inductive and deductive strategy is used to analyze qualitative data, an abductive strategy is preferable for this thesis. Moreover, when applying an abductive approach to the collected data, themes and patterns are explored, but also tested through subsequent data collection (Saunders, et al., 2012) which is the strategy for this thesis. Furthermore, the abductive strategy allows an iterative process (Bell, et al., 2022), which is suitable for this thesis as the first research question lays the ground for the second research question which in turn can require moving backwards in the process.

3.2 Research design

This thesis employs a qualitative case study as a research design to explore the opportunities to transition to circular business models. To explore opportunities, the thesis aims to study business relationships, concepts, views, and behaviors between different actors within an ecosystem.

According to Bell et al. (2022) research that focuses on relationships, meanings, and concepts should be based on data that has been collected qualitatively. Moreover, qualitative data is effective when studying behaviors, views, and preferences that occur in markets (Sreejesh, et al., 2014). Lastly, qualitative data analysis is suitable when conducting a case study (Yin, 2017).

To turn the thesis's stated research questions into a research project, a design of the method needs to be formed (Saunders, et al., 2012). For the first research question in this thesis, descriptive research design will be applied since the question aims to describe and identify what value is captured within material management. A descriptive research design should be applied to questions that aim to identify and describe the characteristics of a studied case (Saunders, et al., 2012; Omair, 2015). However, the second research question is more of an analytical question and thrives to explain the impact of the relations on the studied case. Consequently, a more explanatory study is suitable for the second research question. According to Omair (2015)

a research question that thrives to explain the impact of relations, should have an explanatory research design.

When descriptive research is a forerunner to explanatory research, the research could be described as a description-explanatory study (Saunders, et al., 2012). Therefore, this thesis's method design can be described as a description-explanator study.

3.2.1 Research Strategy

As the research design aims to constitute a project plan, it needs to include strategies to answer the research questions (Saunders, et al., 2012). In this thesis, the key research strategy is a case study, which is attendant in several steps of the methodology, illustrated in Figure 5. The figure also illustrates what output each strategy contributes to within the thesis. The strategies are briefly described in this section, to be further explained in the following sections.

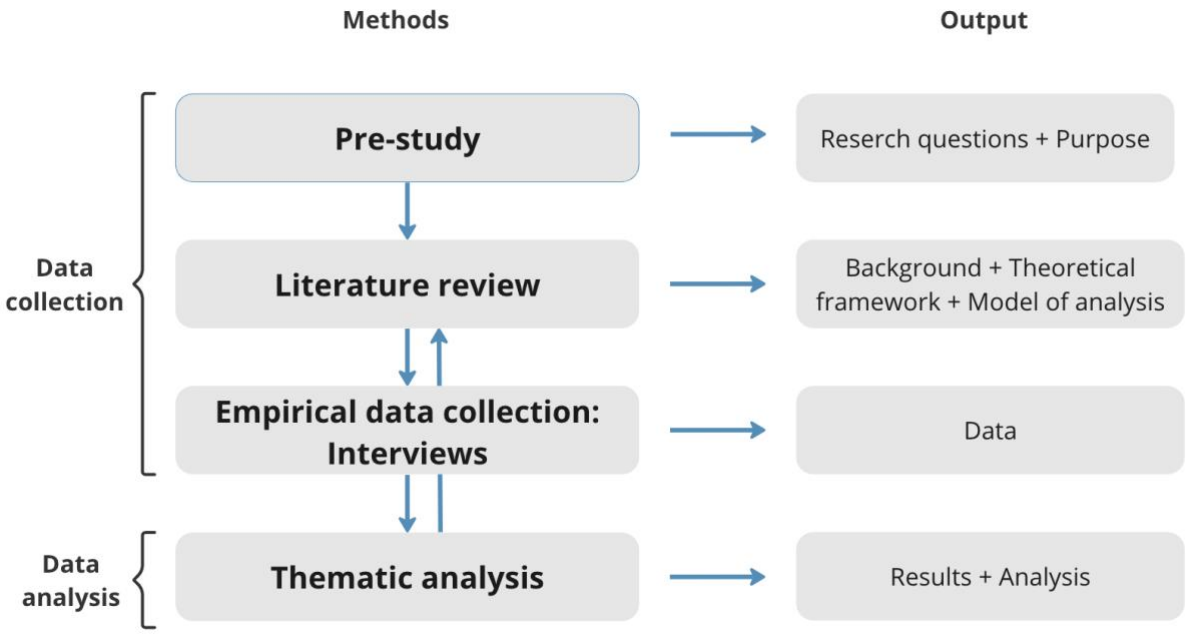

Figure 5 Used methods and their output to the thesis

Research strategies could often be linked to earlier choices of methods or research approaches. For instance, A case study is considered to generate answers to questions stated with "why?", "how?" (Yin, 2009). Consequently, as this thesis asks two "how" questions A case study is chosen as a research strategy. Moreover, a case study is suitable for researching economic structures within an industry (Yin, 2009). Another reason for choosing a case study is the access of participants within the material management available.

As shown in Figure 5, the thesis purpose and the research questions were primarily formed by a pre-study. Although, the development of both research questions was iterative. Thereafter, to obtain a comprehensive background and theoretical framework of the subjects, a literature review was conducted.

A case study was conducted on an ecosystem level of material management. Since a case study's validity is strengthened by using multiple sources (Yin, 2014), six different business scopes within the same industry were included. Thereafter, the collected data were analysed thematically to deliver the results and analysis of the thesis.

3.3 Data Collection

The data is collected from different primary and secondary sources. The primary data is collected from interviews with actors in the material management industry. Secondary sources are used within the pre-studies and consist of documents such as annual reports and different actors' web pages. Furthermore, a literature review of the subjects is conducted which forms the model of analysis.

3.3.1 Pre-study

To gain insight into the material management industry a pre-study was conducted at the beginning of the process. By attending a workshop held by the Sveriges Bergmaterialindustri (SBMI), information was collected regarding the industry's current state as well as its outlook toward a circular transformation. Several different thoughts and opinions from different actors on the circular opportunities in the industry were discussed. By listening to different discussion groups and seminars, both challenges and opportunities of a circular transition were gathered. Conclusions from the different discussions were later compiled. Consequently, areas of improvement could be identified, and research questions stated. Moreover, the workshop gave an insight into who the different actors are in the industry, and how their organizations are related. Accordingly, it gave an understanding of the material flow.

Ta gain a deeper insight into the industry's current state, the workshop was combined with visiting websites of companies within material management, reading articles, annual reports, and news articles regarding material management in Sweden. In addition, several good examples of circular material management outside Sweden were observed by different literature and internet research. Altogether the pre-study led to the development of the purpose and the research questions of the study.

3.3.2 Literature review

A literature review was conducted to explore the knowledge of current theories regarding business models and the circular economy. Several types of approaches could be used for different purposes of the literature review. A systematic review aims to collect all empirical evidence to answer a particular research question or hypothesis and is not as prevalent in business research (Snyder, 2019). An integrative review, on the other hand, is more suitable when wanting to combine several perspectives on the topic (Snyder, 2019). Moreover, an integrative approach is preferable to get a holistic view of the topic and is consequently suitable for both mature and emerging topics (Saunders, et al., 2012). Consequently, an integrative approach is used in the search strategy as the thesis includes both mature topics such as business models and emerging topics such as circular economy and ecosystem-level perspective.

The main source of the literature review is refereed academic journals as they assess quality. Moreover, books are used as they, according to Saunders et al. (2012) often are drawn from several sources and is useful to gain an overview of different topics. Lastly, reports from established organisations are used.

The literature research strategy is based on narrow terms and phrases of a broader subject area as seen in Table 1, which are applied in search engines and online databases.

Table 1 Terms and phrases according to subject

Broad	***Business model***	***Circular Economy***	***Ecosystem***
Narrow	Value dimensions	Strategies	Firm level
	Circular	Principles	Ecosystem level
	Ecosystem	Definitions	Value network
	Value perspectives	Implementations	Relationships
		Decoupling	

By searching for keywords within Google Scholar, several databases are used, which are listed in Table 2. However, papers published through EBSCO's databases are not always found on Google Scholar and are used directly from EBSCO's database search. Different subject areas that are used from each database are listed in Table 2.

Table 2 Used databases and their main subjects

Used databases	***Database's themes***
Google Scholar	Scientific, academic
Linköping University Library	Scientific, academic
Science Direct	Scientific, technical, and medical
Emerald	Business economic
Taylor & Francis Online	Engineering, business, and medical
Scopus	Social science, Physical science

When confirming the relevancy of the journal's topic, the articles are chosen based on their refereed level as well as the most matching keywords. Another parameter that is taken into consideration is the language of publication, which is limited to English and Swedish. The publication period has not been decided for all subjects. However, sources regarding the circular economy were mainly found from 2015 and onwards.

3.3.3 Case study and interviews

An in-depth study that emphasizes detailed information on interactions and behaviour patterns of a unit. Furthermore, a case study frames the base of the research.

The pre-study and literature review identified six key business scopes within material management in Sweden. The different business scopes all together form the thesis's studied

case area. To examine different interactions, behavior, and detailed information about the case, interviews with different actors from each business scope are conducted. Each interview guide was adapted to each business scope. The interviews lasted between 40 and 60 minutes. An overview of the business scopes interviews is presented in Table 3.

Table 3. Overview of selected business scopes and interviews

Business scope	***Position of interviewee***	***Referred to***	***Date***	***Time***
Developer	Project manager	PM (D)	2023-04-05	00:40
Building contractor	Sustainability manager	SM (BC)	2023-04-21	01:00
Suppliers	Product development manager	PDM (S)	2023-04-21	01:00
	Recycling manager	RM (S)	2023-04-21	00:50
Haulage	Business area manager	BAM (H)	2023-04-21	01:00
Recycler	CEO	CEO (R)	2023-04-20	00:40
Waste management	Market area manager	MAM (WM)	2023-04-17	00:40

All seven interviews contained both a structured and a semi-structured part. The structured part aims to discuss questions that will answer the first, descriptive, research question. By using structured interviews, patterns in a descriptive study can be identified (Saunders, et al., 2012). The structured interview aimed to discuss each business scope's key activities, cost and revenue streams, and business relationships. The second part of each interview was semi-structured as it tended to answer the second, explanatory, research question. A semi-structured interview could help to understand relationships in an explanatory study (Saunders, et al., 2012). The semi-structured part of the interview intended to lift the interviewees' envisions on circularity and their perspective on the circularity's opportunities and barriers. The interviews were conducted online and recorded to later be transcribed.

3.4 Data analysis

The interpretation of the data from the interviews started early to enable subsequent data collection. The data from the semi-structured interviews are often analyzed thematically, with the aim of identifying, analyze, and report patterns in the form of themes (Braun & Clarke, 2012). Accordingly, the analysis of the collected data follows the six-phase approach to thematic analysis which is presented below (Braun & Clarke, 2012). After the first step of familiarizing with the collected data, the following steps are made:

Steps of thematic analysis

1. Generate Initial codes
2. Searched for themes
3. Review potential themes
4. Define and name themes

After themes are defined and named, the last step is to produce the report (Braun & Clarke, 2012). The presentation of the research has a traditional approach where the findings are presented by themselves and followed by discussions (Burnard, et al., 2008).

To facilitate the thematic analysis, the interviews were recorded and transcribed on the same day the interviews were held, which primarily enabled the first step within the thematic analysis, to get familiarized with the data. Generated from the familiarization of the data, is the initial codes (Merriam & Tisdell, 2016). And since it is the beginning of the data, an open coding method is suitable, which implies identifying everything that might be interesting. In the next step, the initial codes are categorized according to themes (Merriam & Tisdell, 2016; Braun & Clarke, 2012). The identified initial codes, which later were categorized into themes are shown in Table 4 below.

Table 4 Identified codes and themes of the data collected by interviews.

Initial coding	*business models, revenues, customers, competitors*	
Themes	**Current Business model**	Financial flow
		Revenue streams
		Costs
		Material flow
	Value network	Customer relationship
		Business relationship
		Competitiveness
		Location
	Envisioned circularity	Internally
		Externally
		Challenges
		Demand
		Resource consumption
		Legislation
		Reduced traffic

3.5 Research quality

There are several ways of avoiding biased analysis of collected data. One is to do a respondent validation by returning the transcription to the participants. However, it is time-consuming and has risks of results being modified. Accordingly, the method is not used in this thesis. To still assure the validity of the analysis, 'constant comparison' is used. The method implies that the data is *read and re-read* to search and identify emerging themes to constantly understand the meaning of the data (Burnard, et al., 2008). Similarly, the *test re-test* method is used to avoid respondents not understanding the questions correctly (Sreejesh, et al., 2014). Moreover, to ensure rigour in the research, *equivalence* is used in the interviews by asking alternative forms of a question with the same meaning (Long & Johnson, 2000). The collected data is later compared with the existing literature. By exploring which similarities and conflicts to literature, confidence in the findings is strengthened, and opportunities are given (Eisenhardt, 1989).

To furthermore ensure rigorous, and trustworthy research the set criteria to appropriate humanistic inquiry is considered. The four components, *credibility, transferability, dependability, and confirmability* Should be taken into consideration to enhance internal and external validity as well as reliability and objectivity. *Credibility* is confirmed by demonstrating a deep understanding of the subject matter (Hirschmann, 1986). The selection of interview participants was validated together with one of the thesis tutors, who are well-known in material management. *Transferability* is important to show to what extent the research could be assessed in other contexts. By providing insight and perspectives to the reader, he or she could determine the relevance of the findings to their own situation (Hirschmann, 1986). Therefore, this thesis provides descriptions of the research setting and its participants.

Dependability is enhanced by the research being conducted systematically and consistently (Hirschmann, 1986). Therefore, the collected data from interviews are recorded to be correctly transcribed within the thesis. Furthermore, the thesis seeks multiple perspectives by interviewing six different business scopes within the studied industry. Moreover, the different business scopes participants seek diverse perspectives to enhance an objective and neutral perception of the research findings. By seeking multiple perspectives, C*onfirmability* has been taken into consideration since it refers to not interpreting or concluding research findings with personal biases and preconceptions (Hirschmann, 1986).

Moreover, the ethical aspect is considered to the interviewees. All the interviews are anonymized by not revealing the name of the company or organization that the interviewee belongs to. Thereto, the interviewees are only mentioned by the title they have within the organization or company. Furthermore, all the interviewees' permissions were confirmed before recording and transcribing the interviews.

4 Empirical data

This chapter starts with a description of the material management industry, including its material flow and recycling within the industry. Thereafter, the data from the interviews are presented. Both the different business scope's current business models, the value network, and their envisioned circularity are presented. The six identified business scopes consist of Developers, Building contractors, Suppliers, Haulages, Recyclers, and Waste management.

4.1 Case background

The construction industry is largely dependent on aggregate since it is used as both a filling material in facilities, a foundation in road construction, and a main component in asphalt and concrete (SGU, 2021). Of all minerals that were extracted in 2020, aggregate constituted 93 % (SGU, 2021).

As a result of the planned construction and infrastructural work in the region of Stockholm the need for aggregate is expected to increase (SLL, 2017). Consequently, also the amount of excavated material and the need for transport will increase. The aggregate demand is examined to be 19 million tons per year until 2030 and thereafter reach 25 million tons per year until 2050 (SLL, 2017). However, it shows that excavated material from construction sites will reach 16,3 million tons and that three million tons of moraine and filling material will arise per year until 2030 (SGU, 2020). Accordingly, the amount of excavated material will reach the demanded amount of aggregate.

The use of aggregate involves several different processes such as quarrying, permissions, transportation, construction, landfilling, and recently also recycling (SGU, 2021). Consequently, the management of the material involves several actors different within society such as suppliers, developers, environmental supervision, haulages, and building contractors (Mácsik, et al., 2020).

4.1.1 Material flow

Aggregate is primarily produced through extract quarrying by material suppliers. The extracted stone material gets a classification to confirm that it meets the qualifications to become an aggregate product. For instance, the material needs to meet the AMA requirement that verifies the usage of the final product (Trafikverket, 2020). However, the requirements are different depending on the application. Thereafter, the material is transported, primarily by trucks, often owned by haulages, to the construction site where building contractors receive and use it in the project (Lundberg, et al., 2022).

At the construction site, additional materials are generated through excavation. The excavated materials occur as a result of equalizing the ground, blasting rocks, shafting soil, or demolishing buildings (Optimass, n.d.; Länsstyrelsen Stockholm, 2022). If the excavated are used within the same project as they occurred in, they are used in a so-called "Case A". However, excavated material that is not used in the same project becomes excess material. Länsstyrelsen (2022) in Stockholm defines excess masses as excavated materials constituting, soil, rock, and stone

which occur in connection with construction and infrastructural work and cannot be reused on-site within the specific project.

Owing to limited space at the construction site, the building contractor often wants to dispatch the material that cannot be used as "Case A". The material is often transported through haulage that either leaves it at one of their terminals, a recycling facility or at waste management. To leave the material at a recycling facility or haulage terminal, it cannot be classified as waste. To not be classified as waste, the legislation says that material must have a further use secured and be environmentally and health-wise suitable for planned use (Naturvårdsverket, 2023). To secure further use, it is further explained that the material that occurs must have a quality that could be sold on an existing market, which must be verified within a suitable timeframe.

Consequently, there are two outcomes of the excavated material not used in the project. The material could be retrieved at a recycling facility or haulage terminal if not classified as waste, otherwise, it must be left at waste management. However, it is up to the building contractor where the not waste-classified materials should be transported.

Following the research of the material flow, six different business scopes are identified to be examined within this thesis, illustrated in Figure 6. The following business scopes are studied: Developers, building contractors, suppliers, haulages, recyclers, and waste management.

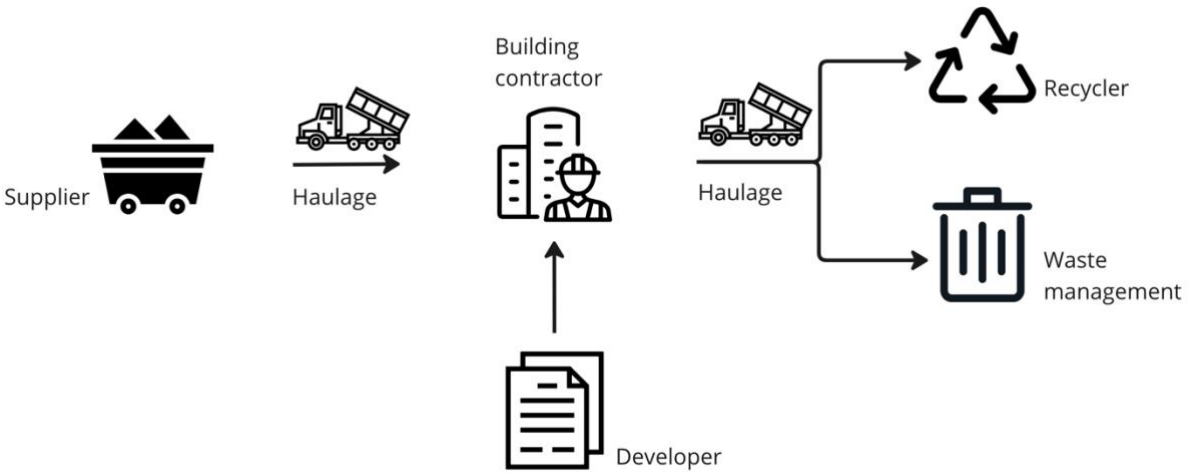

Figure 6 The six examined business scopes in relation to the material flow

In Sweden, 100 million tons of aggregate material is extracted from quarries each year (SGU, 2021). In addition, 40-60 million tons of excavated materials arise in construction, generating substantial amounts of excess (UEPG, 2019). Still, only a fraction of 1% of all sold materials is recycled (UEPG, 2019). A prominent reason for the low degree of recycling is the mean classification of circular products and the lack of definitions (Eriksson, 2022). Additionally, norms and building codes contribute to virgin materials being claimed primarily.

4.2 Current business models

For each business scope, there is an identified business model presented. The identified parts of the business model include flows of cash, materials, and/or services, which are illustrated in a schematic mapping of each business scope's figure. Furthermore, the schematic mappings of the identified business models depict the direct interactions of a business scope's stakeholders.

Developers

In the studied case, the developer is an authority and therefore the projects are all state-funded. The developer has no direct connection to material flow since the developer's role is to order the project by proposing a procurement, which is most often purchased by a building contractor. As seen in Figure 7, the procurement often starts with the developer proposing a request document that contains different conditions for the project. Thereafter, different building contractors calculate the project's cost and leave their offer to the developer. After receiving the offers, the developer chose the contractor with the lowest cost in its offer. Moreover, since the developer is state-funded, they must choose a building contractor according to regulations for an authority. The Project manager (D) explains this further:

"As an authority, we should not impact the development towards any directions with our requirements" PM (D)

Besides building contractors, the procurement can also be signed with private landowners that want to exploit their land, for instance, by leasing their quarries. Moreover, landowners could benefit from the material that will be generated in the project and therefore are willing to pay for collecting and using it.

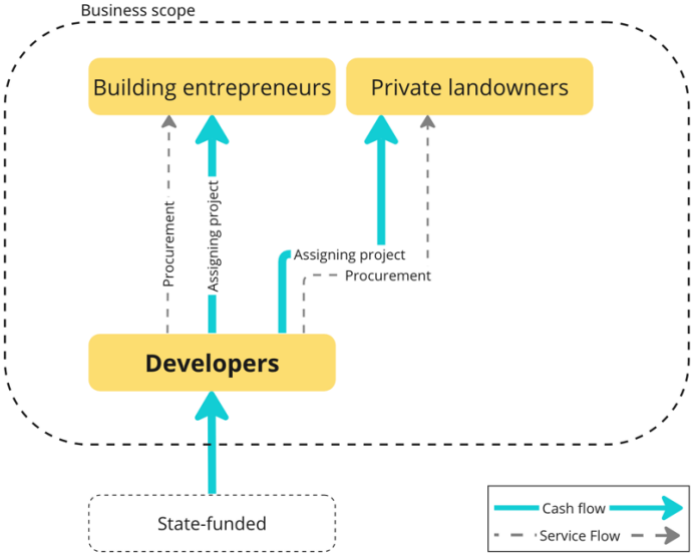

Figure 7 Identified cash flow, service flow and direct stakeholders for the developer

Building Contractor

The building contractor is assigned projects by the developer, which consequently become their main revenue stream, which is shown in Figure 8. After the building contractor assigns the project, the next step is to shift the materials as wisely as possible. The shifting of material implies that the building contractor must remove the not suitable material on the construction

site and retrieve the correct material for the construction. The material not suitable for the construction refers to the material excavated to achieve equal ground, which could imply blasting rocks, shafting soil, or demolishing buildings. In a best-case scenario, the excavated material is handled within the project. In that case, the material is titled Case A material. An example of Case A material is when the materials excavated in the project are used as filling in the same project.

If the excavated material cannot be used within the project, it most often implies a cost for the building contractor. The excavated materials that cannot be used are transported, usually through haulage, to either a supplier, recycling terminal, or landfill management. The excavated rock does often become revenue for the building contractor when left at a supplier or recycling terminal. However, it is often the distance to the facilities that decides if the excavated rock could be left to a supplier or a recycling terminal or if it will be left at landfill management. As the shifting of materials seeks to be as cost-effective as possible, the material is usually left at the facility closest to the project.

Likewise, the material that is retrieved into the project is often bought from a facility that implies the shortest transport. It could imply that the bought material is either extracted or recycled.

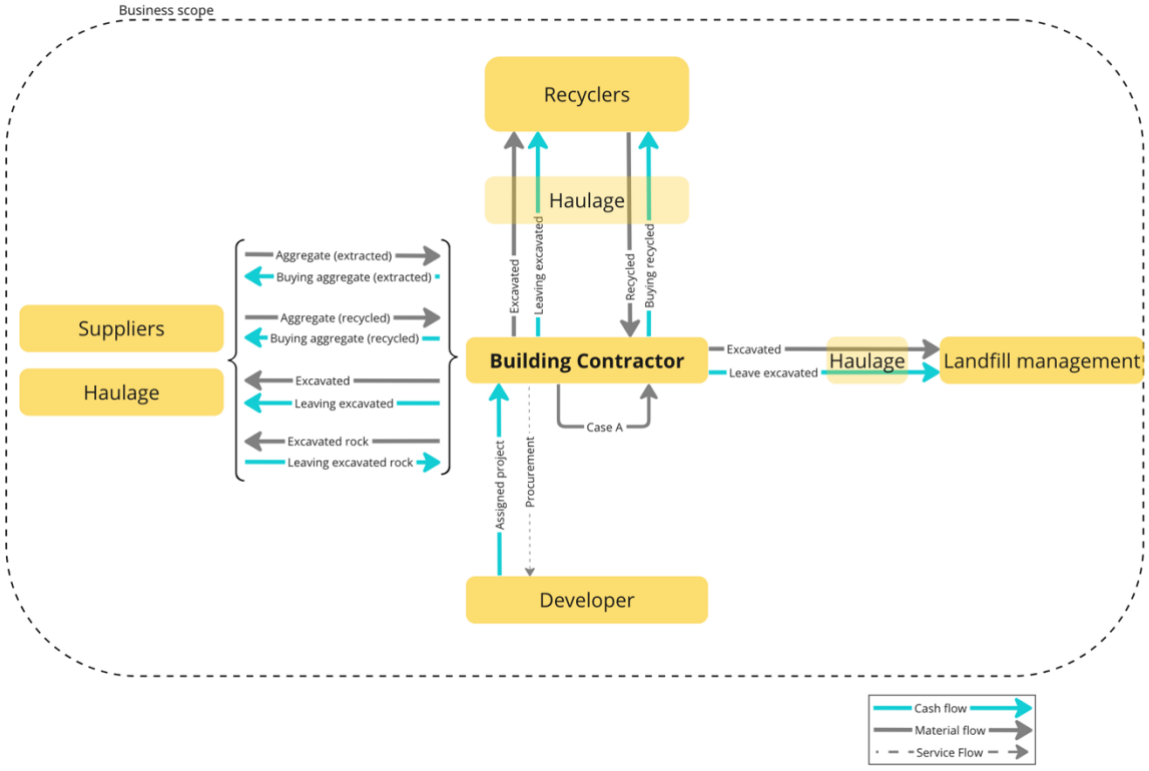

Figure 8 Identified cash flow, material flow, and direct stakeholders for building contractors.

Suppliers

The supplier has several different revenue and cost streams which are shown in Figure 9. Firstly, selling both extracted and recycled aggregate creates revenues. Secondly, they can charge for collecting excavated materials from a building contractor or haulage, creating an additional revenue stream. However, when collecting the excavated rock, the supplier usually must pay

for it. The different businesses are exclusively done with building contractors or through the building contractors' haulages. Lastly, there are large costs for the suppliers to conduct and extract their quarries to produce material. However, the costs for producing recycled aggregate becomes lower than for extracted aggregate since several steps in the production, such as blasting and crushing, could be counted out.

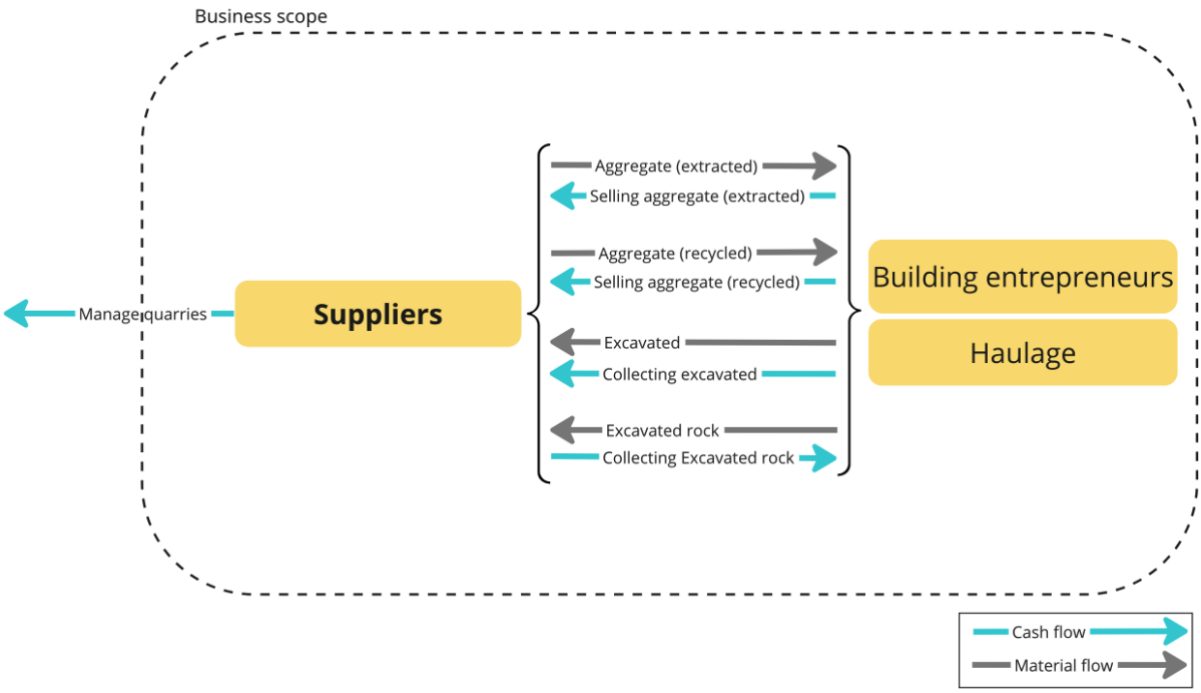

Figure 9 Identified cash flow, material flow, and direct stakeholders for suppliers.

Haulage

The haulage's primary business is to transport materials from a to b, which implies several different routes and is shown in Figure 10. The materials excavated at the building contractor's construction site are transported by haulage to their terminals, to a recycler's terminals, to a supplier, or landfill management. Thereafter, materials are bought either at a supplier or a terminal, depending on the distance and brought to the building contractor's construction site.

The haulage's primary revenue stream comes from the building contractor by invoicing work per ton of transported material. Moreover, the material that is collected and upgraded at their terminals generates revenue when being sold. Lastly, leaving excavated rock at a supplier normally generates revenues as well. The primary cost for the haulage originates from driving the trucks. Additionally, leaving excavated material and buying new or recycled materials entails costs for the haulages.

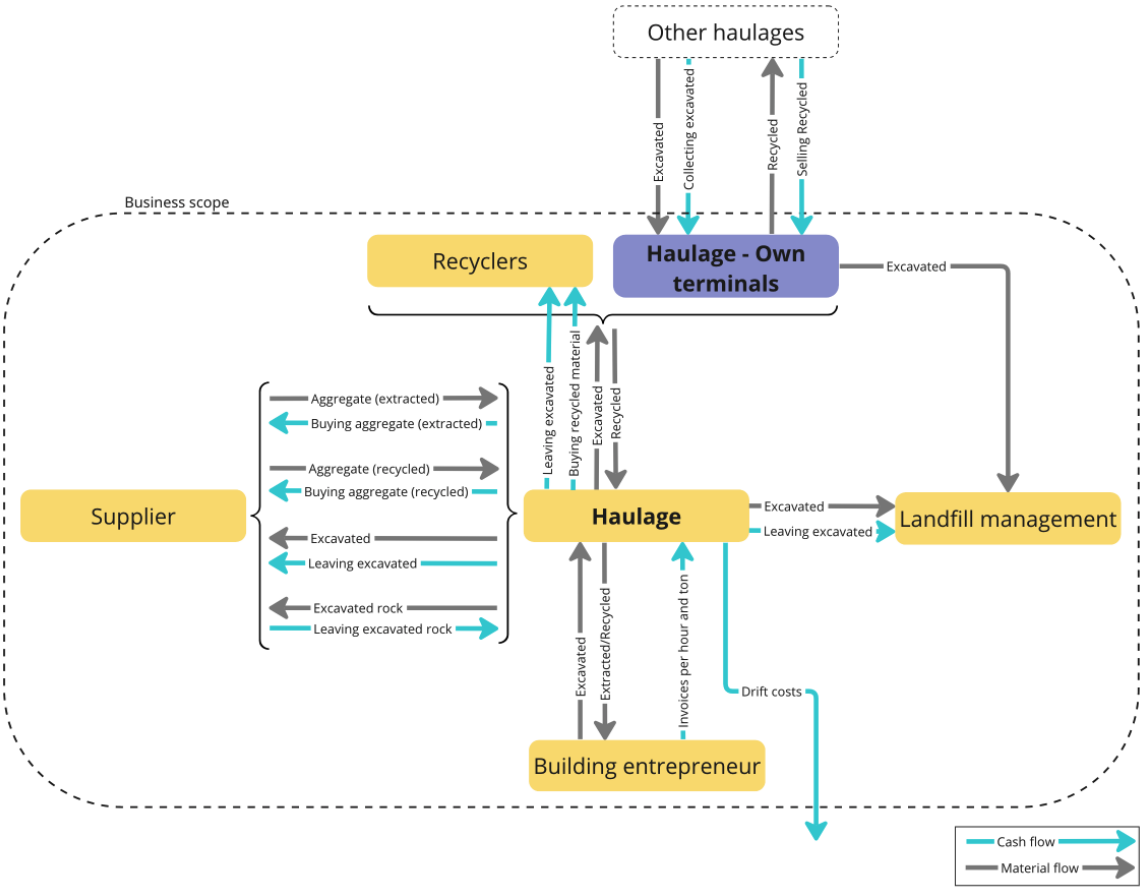

Figure 10 Identified cash flow, material flow and direct stakeholders for the haulages.

Recyclers

The recycler collects all types of material that meets a set quality criterion and can become a qualitative product. To ensure the collection of the right material, tests are done when the building contractor or haulage leaves their materials at the recycling facility. In addition, to guarantee to sell a qualitative product, the materials are tested even after becoming new products. Besides the testing, the investments in machines constitute the main costs for the recycler, both as an investment as well as the operating costs.

The material flow, going both in to and out from the recycler, results in two revenue streams, shown in Figure 11. Firstly, the recyclers charge the building contractor or haulage for the material they are leaving at the recycling facility. Secondly, by selling recycled products another revenue stream is formed.

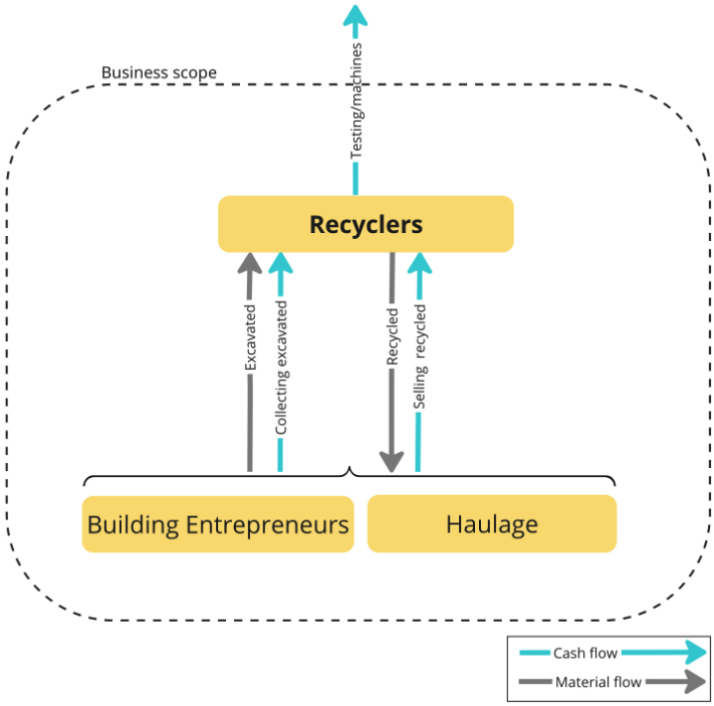

Figure 11 Identified cash flow, material flow, and direct stakeholders for recyclers.

Waste Management

The waste manager collects all types of materials, regarding quality. However, the actor who leaves the masses is charged differently depending on the quality. The price is also dependent on the market, if the waste management is the only collector in a large area the price can increase. The costs that are incurred are primarily the construction of the deposits, which is shown in Figure 12. An additional cost is the measures that are required to be taken before the collected materials can be placed on deposit. Around half of the collected material is not deposited but used for internal projects, such as stabilization or end-covering of deposits.

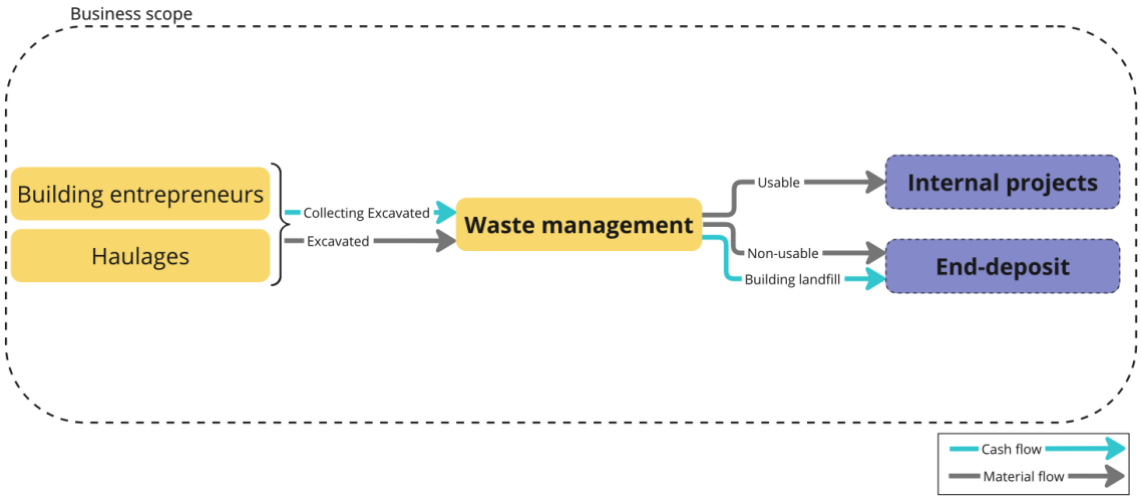

Figure 12 Identified cash flow, material flow, and direct stakeholders for waste management.

4.3 Value Network

There are several different perspectives on how the value networks look within the industry, and what is important to acknowledge with them. Furthermore, the actors within the industry take different measures to manage and extend their relations with the stakeholders within their network.

The Sustainability Manager (BC) has noticed collaborative initiatives arising within the industry as the industry starts to understand that cooperation is required between different actors to achieve circularity.

One of the actors that has initiated a collaboration as such is the developer. To ensure as efficient material management as possible in an ongoing project, the Project Manager (D) arranged a seminar with several actors within the industry. During the seminar, the actors, together with the Project Manager (D), were able to discuss different solutions for the material and leave their own suggestions, which thereafter led to new meetings. However, the suggestions and ideas that arise at the seminar must anchor with other stakeholders, such as Länsstyrelsen and the municipality. Since the developers are an authority, their project must align with both *Länsstyrelsen* and the municipality, since they have a lot to decide on the matter.

To manage the supplier's business relationship with the supplier's customers, the Recycling Manager (S) considers it important to stay competitive by being adaptable in their production to some customers' requirements.

"For instance, the concrete markets do mainly demand extracted material, therefore we do not mix other materials in there." RM (S)

Moreover, the Recycling Manager (S) considers it important to stay competitive by being placed close to the building contractor's or haulage's markets. The Recycling Manager (S) explains it as extra important since the building contractor or haulage often has its quarries, which the Recycling Manager (S) understands will be prioritized. However, the building contractor's and the haulage's main concern when choosing a supplier is the distance between the supplier's facility and the construction site, since that constitutes a large cost for them. Therefore, it is important to be placed close to the market to value the customer's needs and thereby remain in the relationship with them.

Both the Business area Manager (H) and the Recycling Manager (S) confirm that distance is crucial for them as haulages and building contractors when choosing a supplier. Even though both actors will always prioritize taking supplies from their own terminals or quarries they will choose facilities outside their corporate group if the distance from the construction site is too far. The Business area Manager (H) explains that it regards managing their relations with their customers.

"It is required for us to choose other suppliers sometimes in order to be competitive towards our customers since we have to set a matching price that enables us to be assigned the project." BAM (H)

Furthermore, the Business area Manager (H) explains that it is as least as common to work together with their competitors or branch colleagues since the geographical distance controls a lot for the invoicing to their customers.

The relationship within the value network is also managed by actors that actively have chosen not to compete with their customers for the reason of not losing them as customers.
The Market area Manager (WM) explains that they, as waste managers, cherish the relationship with their customers by not putting out their new products or material on the market. The Market area Manager (WM) explains it further:

"Since we have customers who do that, we do not want to do the same function since that would compete with them. We only do it in those cases when we are directly requested to do so but that is seldom" MAM (WM)

Likewise, the haulage has actively chosen not to compete with their customers, the building contractor, in that they are not calculating the projects that they are offered by developers. The business area Manager (H) explains that calculating the projects is rather the building contractor's job, which is also requested by the developers.

"Sometimes we are an asset for our customers (the building contractors*) and sometimes we are their competitors. But we do primarily want to be partners rather than competitors for them" BAM (H)*

Therefore, offering the calculation service is considered by the Business area Manager (H) to be outside the haulage's business scope.

However, the Market area Manager (WM) considers their network of waste managers as stable and finds it rare with new actors. Correspondingly, the CEO (R) considers that their recycling facility has had an unchanged number of customers since the company's start, around fifty years ago. In other terms, the CEO (R) has not noticed any increased business because of environmental incentives from customers. Furthermore, the CEO (R) explains that their customers consist of building contractors closely located, who have been well known since the recycling company started.

4.4 Envisioned circularity

This chapter presents how circularity in material management is envisioned from the different business scopes' perspectives. The chapter is divided into internal and external circularity, in other terms what the actors envision could become circular in their business scope and what can become circular in the whole industry.

4.4.1 Envisioned circularity internally

As an authority, the developer must follow regulations which imply that they cannot put any specific requirements on the proportions of used recycled material in a project, which the Project Manager (D) regards as an obstacle for them to foster circularity. The Project Manager (D) explains that decisions regarding the proportion of recycled material are instead left to the building contractor, who is assigned the project. As an authority, the developer's requirements rather focus on time and cost. The Project Manager (D) explains the conditions further:

"If we as developers put requirements that only recycled materials should be used, it can hinder the contractor to find materials in time which will affect the timeframe. Furthermore, the assigned contractors must get their economy together and it is therefore up to them to choose the material." – PM (D)

Moreover, the Project Manager (D) explains that the choice of material depends on the transport. The building contractors must be allowed to collect material from the closest quarry to reduce both environmental and economic impacts. Altogether, the Project Manager (D) considers the regulations to limit their opportunities for becoming circular.

For a building contractor, there is always an aspiration to reuse as much material in *Case A* as possible according to the Sustainability manager (BC). However, it is less common to buy recycled material from a supplier.

"An obstacle for us to buy recycled material is that we do not know if the material has been used in any other project before. However, some materials that we buy can contain recycled material as long as it is proved to have the same quality as new" SM (BC)

However, suppliers are already offering recycled products today. One of the reasons for doing that, the Product development Manager (S) explains:

"We must work towards the society that wants us to do this and aim to reach the global goals. Therefore, we are putting an eco-brand on the market to show that our circular products are as good as new products" PDM (S)

For the suppliers, it is both faster and cheaper to produce recycled products than extract material to produce products since several steps could be reduced in the process. However, the Product development Manager (S) explains that the intake of used material is limited and therefore constitutes an obstacle to increasing the production of recycled products. Since the suppliers conduct quarries as well at their facilities, the intake of used material is namely delimited by regulatory authorities.

The Sustainability Manager (BC) introduces another opportunity to use less virgin material for building contractors, namely, to look at other materials, for instance from house demolition,

assuming that they are fulfilling the quality criteria. However, that would require several industries to discuss with each other and an iterative process where the material would be tested.

Correspondingly, the CEO (R) of the recycling facility sees possibilities in using materials from other industries to develop new products. The CEO (R) explains further how this could be an opportunity for them to develop circularity internally:

"We need to think outside the box regarding other products. There are good things in products that not everyone thinks of, that could be used in other contexts than just the construction industry." CEO (R)

Moreover, the CEO (R) tells that they do already have customers outside the construction industry.

Within haulage, the Business area Manager (H) is aware of how one can remain in the same way of thinking since the business is working well. To break that pattern of thought, the Business area Manager (H) believes that the view must be widened internally. However, the Business area Manager (H) thinks that economic incentives, such as earning sustainable credits, and a requirement specification within the procurements are missing for them to start thinking outside the old frames.

Conversely, the Market area Manager (WM) does see economic incentives in reusing material as waste managers. The market area manager (WM) explains:

"Cost-wise it is always more expensive for us to fill space in our deposits; therefore, we always try to reuse as much material as possible within our internal projects" MAM (WM)

Another circular opportunity for waste managers is to refine some of the materials that they collect. For instance, the Market area Manager (WM) explains that rock that occurs in the received material is mainly sorted out today for the purpose of not taking up space in the deposits. However, they have tried to refine and crush it for use in internal projects, and therefore the technique is established within the company. As a result of that, the Market area Manager (WM) believes there are opportunities for them to become more circular internally.

To realize circularity within the company, the Market area Manager (WM) believes that they would refine and crush the rocks more regularly. However, they do not want to sell refined products on the market since it is not their position and would risk losing their customers. To avoid competing with their customers, the Market area Manager (WM) does instead consider refining and crushing rocks towards project-specific solutions. However, that will require planning from the building contractor. The market area manager (WM) believes it could be a challenge because of the just-in-time attitude that prevails with building contractors today.

Moreover, the Business area Manager (H) at the Haulage sees several different measures to be taken internally. For instance, the haulage could be driving smaller trucks over shorter distances

and in general, driving different routes to other terminals to enable filled retour-transports. Another measure to take would be to establish several terminals, however, the Business area Manager (H) considers it a challenge in setting up new terminals since the space close to the market is limited.

Correspondingly, the CEO (R) of the recycling facility believes that a step towards expanding the circularity within the firm is to be located in several places geographically to not be excluded by customers because of the distance. Preferably, the CEO (R) envisions one terminal close to every large city, but that will require investments and knowledge that are not within the company today.

Furthermore, to achieve a better material balance in the projects the Project Manager (D) tells that the developer has in recent years started to look at several factors when planning the projects. For instance, factors such as how the road should be put in the terrain to get as small amount of excavated material as possible, or where the project is running in relation to E4an to not create damage on the landscape or take arable land, are investigated. However, it is often the required planning type that decides what is considered important in project planning. Some projects do not have any eligibility requirements in their planning and therefore it could leave space for the specialists within those projects to decide what they are interested in or consider important. However, both *Länsstyrelsen* and *Naturvårsverket* must always accept the developer's suggestions.

However, to reduce the environmental impact of the transport, the developers are investigating what the trucks are fueled with. Although they cannot promote one specific actor, hence the regulations, they always look wide for fossil-free options to stay competitively neutral. Moreover, one of the suppliers is using barges for some transport, to reduce the traffic on the roads.

4.4.2 Envisioned circularity externally

In an optimal scenario, according to both the Product Development Manager (S) and the Recycling Manager (S), the material would never leave the construction site and circulate within the project. However, they explain that there are several measures to take before that scenario could be realized. For instance, the Recycling Manager (S) believes that circularity within the industry will require planning between municipalities and contractors in the early phases.

Both the Product Development Manager (S) and the recycling manager (S) regard the industry as complex and therefore an obstacle in itself. One of them looks at it as mature where the current business models are profitable and therefore difficult to change. The other one means that it is several factors causing the complexity, such as the industry containing several different occupational groups, much legislation, and that it often is project-based. An additional factor in the complexity, according to the recycling manager (S) is how their business as suppliers are affected by what materials occur within the project. For instance, if a lot of excavated rock emerges in the market, the suppliers lose competitiveness towards their customers.

Furthermore, the Market area Manager (WM) suggests that a solution to decrease resource consumption would be to look at other materials from other markets. For instance, by making use of parts from house demolition. However, that would require investigating the strength and functional quality of the material. The Market area Manager (WM) considers it would be a large opportunity for the recycling actors since it would make it easier for them to make a profit out of collecting and selling concrete and construction waste from demolition.

The Sustainability Manager (BC) is hoping that the number of terminals for recycling material will increase. Correspondingly, the Business area Manager (H) believes that they as a haulage need to work with several terminals within the industry both to avoid late transport and to not create too large distances between them. To reduce the traffic of material both the product development manager (S) and the recycling manager (S) do agree on placing new recycling terminals closer to the construction. In that way, both traffic and virgin material would decrease. But to realize that scenario, both permissions to build terminals, and a system that can assure different quality requirements, are necessary. The recycling manager (S) does also state that if circulation of excavated rock happened closer to, or within, the construction site, that would constitute a threat to them as suppliers.

Forward, an expectation from the Sustainability Manager (BC) is also that material management should be based on a whole region rather than on the projects individually. In that way, the different projects that are running simultaneously within a region can be used to find an increased balance between the supply and demand of the materials. Currently, the Sustainability Manager (BC) has noticed initiatives to cooperate between different projects with the purpose of evening out the imbalance of the materials and thereby transferring them to a more circular model. Correspondingly, the Business area Manager (H) suggests that several projects should be combined to enable a more effective flow of material.

Today the business area manager (H) views the industry as square regarding the logistic of moving the material. Consequently, it complicates the possibility to fill the retour- transports, which the Business area Manager (H) explains by:

"Generally, in a project, the material is only transported away from the project the first third of a project, in the second third material can go both in and out, and during the last third material is only coming in. Moreover, when driving to a landfill there is no material to bring back, which forces you to go to an additional location" BAM (H)

Likewise, the Recycling Manager (S) understands the challenge of construction sites often do not allow too much material at the same time hence various stages in the construction. This problem, which often causes empty transport, requires a solution between several actors, according to the Business area Manager who suggests that several projects should be combined. However, the Business area Manager (H) believes that there is still a problem with the timeframes between the demand and supply of the masses not matching each other. Which is the explanation as to why it has not been done yet.

The CEO (R) of the recycling facility confirms that their customers often leave with empty retour-transports since it is uncommon for them to buy material after leaving excavated material. The CEO (R) believes it mainly depends on, for the same reason as the others mention, the shortage of space at the customer's construction site.

To avoid that problem, the recycling facility collaborates with a transport business that seeks to balance the demand and the excess of masses between different projects. Also, the Recycling Manager (S) has noticed different initiatives trying to combine several projects, aiming to even out the number of masses, which would decrease the empty transport. However, the CEO (R) tells that those initiatives have been met with resistance, which the CEO (R) believes depends on the traditional way of ordering one specific haulage for a project to not risk the business relations to the haulage. Correspondingly, the Recycling Manager (S) is not convinced about the market enabling those solutions yet and explains it as:

"It will surely occur actors that provide a mass balance system, but it is pretty far from now, there have been earlier initiatives, but the market is not there yet." RM (S)

Furthermore, the transfer to circularity is, according to the Sustainability Manager (BC), challenged by the pricing and distances between different facilities.

"When we want to get rid of excavated rock we try to be as cost-effective as possible, which impacts the choice of leaving it to a recycler or a landfill" SM (BC)

Likewise, both the product Development Manager (S) and the Recycling Manager (S) agree that there are economic incentives missing today for building contractors and haulages to recycle excavated materials. The Recycling Manager (S) believes it depends on the large rock resources there are in Sweden, which implies low costs for extracted rock material. The Product development Manager (S) adds:

"We must find a model in the industry that benefit the actors who excavate material, to leave them at someone who creates products of them, instead of sending them to places where they do not become circular products, only because it is cheaper to put them on landfill, as today". PDM (S)

The Product development Manager (S) suggests that one economic incentive would be to impose taxes, not only on the material that is placed in a landfill but also on excavated materials that are not recycled.

The Product Development Manager (S) explains further that since a few years back, the materials that are placed in a landfill must be taxed, which has turned out to be effective. However, the excavated materials are not yet taxed and therefore much of the excavated materials end up as end-covering in quarries or landfills. The Product Development Manager (S) means that usage as such does not imply actual recycling of the materials, but only getting

rid of them when naming it as recycling. Instead, a prospect is that it should be beneficial for building contractors to leave the excavated material to someone that creates new products out of it. Besides imposing taxes on excavated materials that are not being recycled, the product development manager (S) adds that there should also be a clear direction for which products the excavated materials could become. Altogether, both the Product Development Manager (S) and the Recycling Manager (S) think that the industry today encourages sending the excavated materials to a landfill rather than leaving them to someone that can create a usable product out of it again.

To create incentives for decreased resource consumption, the Market area Manager (WM) requests a measurement or some type of value that measures sustainability. To ensure sustainability that creates value, the Market area Manager (WM) believes that the industry must be able to tell in what extent extracted material or transport has been saved. Furthermore, there is an incentive in appearing as a sustainable firm. The Recycling Manager (S) expresses a similar opinion regarding that sustainability needs to be defined in the same way within the whole industry:

"Make sustainability measurable, so it can be charged, not much will happen before that" RM (S)

Correspondingly, the Business area Manager (H) thinks that economic incentives are missing for circularity. As a result of the low price of new material, recycled material will never be considered worth its price. Furthermore, the Business area Manager (H) believes that lowering the already low price of recycled material will only make the developers back from the recycled material even more, since questioning the low price. As suppliers of recycled material, the CEO (R) confirms by the following statement that it is difficult to compete with the low price of extracted rock material:

"Several actors are coming with requests as they are interested in recycled material, but if there is a price difference, they are not motivated enough to buy the recycled material." CEO (R)

Also, the Product Development Manager (S) and the Recycling Manager (S) notice an interest in their recycled material from their customers. However, the Product Development Manager (S) means that their customers are regulated by public procurements, in a way that hinders them from buying recycled material.

"…unlike the private trade and Industry, which can say 'now we will buy from you since you have made something that is smarter', but they (the authorities) must do it the formal way which create a slow change process" PDM (S)

Even the Recycling Manager (S) notices a difference in the requested material when the municipality is the end customer from when a private actor is. Explaining that private building contractors are often interested in different certifications and markings, while in a project where

the municipality is the customer, there is a small space for trying new things, and the process often gets done "by the book".

Correspondingly, the Product Development Manager (S) notices that knowledge about the recycled material's capability does exist among the operating actors in the industry.

"That knowledge does not mirror the Swedish legislation for acquiring construction material, which results in the customers not having a choice but must request virgin material." PDM (S)

The Product Development Manager (S) further explains that their recycled products do fulfil the national criteria of markings and risk assessment based on European standards. However, Swedish legislation rather investigates the origin of the material, resulting in circular products reaching European standards and becoming disqualified in Sweden.

Similarly, the Sustainability Manager (BC) considers the legislation in the industry as an obstacle to the industry's circularity. Even though the legislation says that everything that is not waste should be reused, it also classifies all excavated materials as waste if not used directly. Correspondingly, the Business area Manager (H) believes the legislation needs to change to not say that all the excavated materials are waste if not used directly.

Similarly, the CEO (R) thinks that the industry needs to be more regulated, for instance requiring a certain per cent of recycled material or using the same type of environmental product declarations (EPD) as used within house construction. The CEO (R) adds:

"Furthermore, seeking and getting permissions must be standardized throughout the country, to avoid being interpreted differently as it is today." CEO (R)

Further on the subject of legislation, the Business area Manager (H) believes the require-specification within a procurement should contain regulations that a certain per cent of the material should be recycled. Instead, the building contractors deselect recycled material today when it is offered by the haulage since it is opted out by developers. The Business area Manager (H) believes that the reason why developers decline recycled materials is a lack of knowledge. Therefore, even though there is an interest in recycled products from the customers it is not sold since the developers are not convinced. Accordingly, the industry needs to make the developers trust that the actors within the industry know best. To fill the knowledge gap, the Sustainability Manager (BC) believes that they as building contractors could create a consensus on circularity with *Länsstyrelsen* by arranging discussions with them. The Sustainability Manager (BC) does namely believe that the consensus on circularity between the industry and the authorities is missing today.

5 Analysis

This chapter analyses the collected interview data based on the literature review. Firstly, each business scope's current business model is analysed to examine which circular strategies are included in the value propositions and capturings. Secondly, the envisioned circularity and the value network are analysed to examine how the ecosystem-level enhances respectively limits the move towards more circular business models.

5.1 Circular strategies in current business models

As the value proposition is defined as the firm's product and service offering (De Angelis, 2018; Leviäkangas & Öörni, 2020; Nußholz, 2018), all of the business scope's value propositions within the studied case are defined as their material or service flow, which is illustrated in the schematic mappings in section *4.2 Current business models*. Furthermore, as the value capturing is defined as the cost structure and revenue streams (De Angelis, 2018; Leviäkangas & Öörni, 2020; Nußholz, 2018), the business scope's value capturing is defined by their cash flows, also illustrated in section 4.2 *Current business models*.

To capture a value, the value must first be proposed to the customer (Shafer, et al., 2005; Sjödin, et al., 2019). Therefore, to examine the circular strategies within the business model, the analysis will consider the value proposition i.e., the material and service flow, and the value capturing i.e., the revenue streams and costs.

In Table 5 below, the different business scope's value propositions and value capturings are listed vertically, and the different circular strategies are listed horizontally. Furthermore, the table shows which circular strategy or strategies are used in which value proposition or capturing. The circular strategy *remanufacture* within the Technical Circular Economy System diagram by Ellen MacArthur Foundation (2019) is not illustrated in the table since no business scope uses remanufacturing. To use the remanufacture strategy the product is required to go back to the product manufacturer (Ellen MacArthur Foundation, 2019). However, in this case, the product of rock and soil material is already in its parts when considered a product and therefore it is difficult to remanufacture.

Table 5 The different circular strategies used in the current business models.

Business scopes **Value propositions** **Value capturings**	**Circular strategies**								
	Prolong	Reuse	Recycle	Slowing	Closing	Narrowing	Decoupling from material resources	Decoupling from environ. impact	
Developer									
Assigning projects		x		x	x				x = if combining several projects
Building Contractor									
Case A	**x**			x	x	**x**	**x**	**x**	x = depends on definition of excavated material
Leave excavated rock							x		x = depends on definition of excavated material
Leave excavated material							**x**	x	x = if the shortest transport
Buy extracted									
Buy recycled							x		
Supplier									
Selling extracted									
Selling recycled			**x**		**x**		x		
Recieving excavated							x		x = depends on definition of excavated material
Haulage									
Transport material								x	x = if the shortest transport
Selling recycled			**x**		**x**		x		
Recieving excavated							**x**		
Recycler									
Upgrading material			**x**		**x**		**x**		
Waste management									
Recieving Excavated							**x**		
End-deposit									
Reuse internally		**x**							

Developers

The developer's cash flow differs from the other scope's cash flows since its revenues are mainly state funding. Consequently, the developers' value-capturing differs from how it is often described in the literature. As an authority, the developers would rather capture their value from revenues in a regulated manner, than capture the value of their value proposition, which is often how value capturing is described to function (Shafer, et al., 2005; Sjödin, et al., 2019).

Moreover, the developer's value proposition is mainly constituted of assigning projects which are not directly coupled with resource consumption. However, the projects that the developer assigns entail extracted material, which according to UNEP's (2011) definition of a material resource, implies that the assigned projects are coupled with material resource consumption.

However, the developer has started to plan the projects in earlier stages which result in finding several actors that can be assigned various parts of the projects. When assigning an actor that is closer to the project it implies a lower cost for the developer meanwhile as the emission impact of transport is decreased. In this case, the environmental change depends on an economic change, where the lowest price controls which actor is assigned. Similarly, Bocken et al. (2014) state that an environmental change will only be done in line with economic changes.

Moreover, the increased planning has allowed several projects to be combined, which in turn enables the assigned actors to retrieve and leave material at several projects with shorter distances. That in turn implies that both resource input and waste as well as emissions and energy are minimized within several projects. Geissdoerfer (2017) explain that slowing, closing, and narrowing loops result in minimized input and waste, emission, and energy leakage. In the studied case, the project planning in the initial stages allows the resources to be kept within the assigned actors. Therefore, the resource flow could be referred to as closed, as the resources are kept and reused between the assigned actors. Altogether, if looking at several combined projects as one system, the resource flow could be defined as closed, since the loop closes between one actor's post-use and another actor's production. Additionally, the resource flow could be defined as slowed since the material is reused between the actors. However, to create the closed and slowed loops the combining of projects is required.

Thus, to summarize, the planning and thereto the combining of projects within the developer's current business model do result in several circular strategies, such as closing, slowing, and reusing are being used. Thereto, the combining of projects and thereby the collaboration with several actors could imply more value being captured since the developer is able to choose among several actors that offer the lowest cost for that specific part of the project. Minerbo et al. (2021) states that value capturing could increase through collaboration with customers since value-added services could be charged. In the studied case the developer's value capturing is increased by collaborating with more actors. Even though no additional services are offered by the developer, the fact that the material is closer located to the actors increases value for the actors who thereby could offer a lower price. Altogether, an increased collaboration implies increased value capturing for the developer.

Building Contractor

The main value proposition for the building contractor consists of shifting the material at the construction site. Therefore, most of their revenue stream and costs are connected directly, or via haulage, to the supplier. However, their main revenue stream comes from the developer who assigns them the project. The remaining cost and revenue streams occur when the material is shifted. Receiving material from another actor in the project always implies a cost. Discarding the excavated material from the construction site could generate both cost and revenue streams. For instance, if the excavated rock is left at a supplier or haulage, it often implies revenues. In that case, economic growth is created by material not extracted to create economic value but by an excess excavated with the intention to equalize the ground. Therefore, the value captured from the excavated rock could be seen as economic growth decoupled from material resources. Another view is that the excavation of rock indirectly aims to create economic value and therefore could be seen as deliberately extracted natural assets, which goes in line with UNEP's (2011) definition of material resources rather than excess material. Consequently, whether the revenue of excavated rock is decoupled from material resources or not depends on the definition of the excavated rock.

The destination of excavated material is often decided by the distance, as the shorter distance means the least costs. The fact that longer transport implies more cost could be seen as a negative environmental impact is decoupled from economic activity, as shorter transport and thereby less emissions imply less costs. In other terms, there is no economic growth in longer transport, and therefore the value proposition is decoupled from environmental impact (Kjaer, et al., 2018). The sustainability manager (BC) states that since the distance often decides where the excavated material is transported, recycling facilities are often deselected since it implies long transport. Also, the CEO (R) confirms that since they only have one facility they are often far from their customers. Consequently, when the suppliers deselect the recyclers the environmental impact of emissions is avoided even though the material is not recycled. Thereby, a so-called rebound effect, when a circular strategy has the opposite effect (Zink & Geyer, 2017), is avoided. It could be explained by if the supplier had transported the material to the recycler, despite a longer distance, it would have implied a negative environmental impact, which could be an example of when a circular strategy has the opposite effect.

The sustainability manager (BC) explains that keeping the material within the same project, in case A, implies the least costs. It could be explained by the Technical Circular Economy System Diagram, adapted from Ellen MacArthur Foundation (2019), which illustrates different end-of-life processes. In the diagram, the smallest cycle *prolong* contains the most value since it does not imply any other production steps like the other end-of-life processes do. Similarly, Case A does not imply any other production steps since it is reused by the same user directly. As a result, both the loop of material and energy are closed within the same process step. However, there is a difference between Case A and the prolong-process in the Technical Circular Economy System Diagram since the excavated material is not prolonged at the building contractor but reused in a new context. Yet it does not correspond to the *reuse* process either since it does not involve a service provider. For this reason, *Case A* materials could be seen as a step in between the *prolong* and *reuse* process.

Furthermore, *Case A* could be analyzed through the circular strategies of closing, slowing, and narrowing resource flows. Firstly, the resource flow is closed as the material stays within the construction site. However, 'closing' a loop according to Bocken et al. (2016) only occur between a post-use and production. Consequently, deciding whether case A is closing a resource flow or not depends on if the excavated material is defined as used or not. The same ambiguity is relevant regarding if the loop of material is slowed or not. Bocken et al. (2016) state that a loop is slowed if the material is reused. Once again, to say if the excavated material is reused or not depends on whether it is defined as used before it was excavated or not.

Moreover, by using the excavated material within the same project as *Case A*, the resource input into the project is minimized, as less material must be received from outside. Bocken et al. (2016) state that if fewer resources are being used per product the resource flow is narrowed. In this case, the project does not necessarily imply fewer resources, but the use of natural assets is minimized since the excavated material could fulfil the same purpose. Therefore, the building entrepreneur's business model uses narrowed flow when shifting material internally, compared to if all the material would have been imported externally. Moreover, Case A materials do not end up in waste management and therefore the amount of waste is minimized. Lastly, transport is avoided as the material must not be discarded from the construction site. Consequently, emissions are minimized. Altogether, Case A results in minimized waste, emission, and energy leakage. These factors stated by Geissdoerfer et al. (2017) are to be minimized if the loops are closed, narrowed, and slowed.

Since reusing the material in *Case A* does not imply transport from the construction site it does not have a negative environmental impact from pollution. It follows that shifting material as in Case A constitutes a value proposition that reduces the environmental impact of an economic activity. It is, therefore, according to UNEP (2011) decoupled from environmental impact. Furthermore, the excavated material used in Case A is not deliberately extracted from natural assets. For this reason, it could also be stated that Case A is decoupled from resource consumption (UNEP, 2011).

The main value proposition of shifting material also implies receiving material at the construction site. When shifting the material in the projects to extracted material is both material resource dependent and causes environmental impact due to the transport from the supplier. It follows that the building contractor's value proposition of shifting material with extracted material is coupled with both resource consumption and environmental impact, according to the definitions of decoupling of (UNEP, 2011). However, if buying recycled material there are no natural assets that are deliberately extracted, and therefore the value proposition is decoupled from material resources. However, the recycled material still requires transport which generates emissions and couples the value proposition with environmental impact.

Supplier

Out of the supplier's three revenue streams, there is only one that is directly coupled with deliberately extracting natural assets. Therefore, the revenue stream of selling extracted

aggregate is coupled with resource consumption, according to UNEP's (2011) definition of a material resource. The revenue from selling extracted material does neither correspond to the circular processes of the Technical Circular Economy system diagram nor slowing, closing or narrowing of the resources. The remaining two revenue streams imply selling recycled aggregate and collecting excavated material and therefore, economic growth emerges even though it is decoupled to resource consumption as it only requires excavated material.

Moreover, the value proposition of offering recycled aggregate is explained by the Recycling Manager (S) to be both faster and cheaper than offering extracted aggregate, since several production steps can be removed. This is explained by the value being embedded in the products when being recycled (Ellen MacArthur Foundation, 2023). Furthermore, it corresponds to the example, given by Stahel (2016) of reusing a glass bottle, which is both faster and cheaper than producing a new one from minerals.

The Recycling Manager (S) explains that the production of recycled material saves costs since several process steps could be removed from production. Thereby, the saved costs from recycling are rather due to saved energy than saved material. This opposes Nußholz (2018) states about cost is being saved in recycling due to substituting raw material. But owing to large aggregate resources in Sweden, and thereby, low cost for raw aggregate material, there are small or no costs to save when substituting the raw material for recycled material. The costs saved when selling recycled material are rather due to the energy saved by removing process steps from the production. This could be explained by the Technical Circular Economy System Diagram, which illustrates that recycling material closes the loop of both material and energy (Ellen MacArthur Foundation, 2023). Given this, it is rather the closed loop of energy than the closed loop of material that is cost saving when recycling, since it is the production steps and managing the quarries that implies the largest costs for the suppliers. However, the excavated material collection often constitutes a cost for the suppliers since they mainly collect excavated rock. In line with what Nußholz (2018) states, collecting material from the customer could often result in costs.

The value proposition of collecting excavated rock as well as upgrading it to new products, the loop of resources is closed between post-use and production. According to how Bocken et al. (2016) defines a closed resource flow, this value proposition in the supplier's business model uses the *closing* circular strategy. However, the value proposition of selling recycled aggregate does not constitute a large revenue stream according to the Recycling Manager (S), which could be explained by the total amount of recycled aggregate only constituting 1% of all sold aggregate. To increase a value-capturing either the price, volume or collaboration could be increased (Minerbo, et al., 2021). In this case, an increased price on the recycled material would not be a solution as it is already rejected at a lower price than extracted aggregate today, according to the CEO (R) and the Business area Manager (H). Furthermore, the opportunities to increase the volume are delimited by regulations, since the suppliers are only allowed to collect a certain amount of excavated material at their facility. Despite these circumstances, there is a remaining approach to increase value-capturing, presented by Minerbo et al. (2021) by increase collaboration. By collaborating with the customers, the supplier could offer value-

added services within their proposition, and charge extra. This would require the building contractor or haulage to accept a collaboration. Both the Business area Manager (H) and the Sustainability Manager (BC) state that they are open to collaboration between different projects or with different terminals, which indicates that a collaboration with the supplier is possible.

Haulage

The Business area Manager (H) explains that it is often the distance that decides if the material goes to a terminal where it can be recycled or to waste management where it becomes a landfill. In the case of haulage, transport is the most energy-consuming process, as driving is their main value proposition. For the Haulage, it follows that excavated materials that are transported to a nearby located waste management require less energy than if it was transported a longer distance to a recycling facility. This contradicts how the different end-of-life processes embed energy value in the Technical Circular Economy System Diagram by Ellen MacArthur Foundation (2019), where landfill embeds less energy than recycling. Moreover, sending material to waste management could imply less environmental impact if it signifies the shortest transport. Altogether, the fact that transport is energy-demanding and thereby costly, results in the haulage tending to use the end-of-life process that is less coupled with environmental impact, in terms of emissions from transport.

However, since the transport constitutes a large cost for the haulage, they always aspire to drive as short transports as possible, which in turn implies the least possible environmental impact. Consequently, the shorter distances and thereby the less environmental impact, cost less since the same amount of material could be transported and invoiced, but at a lower cost. Therefore, their economic activity could be seen as decoupled from environmental impact, since more costs are saved when less emissions are generated. It could be seen as the less environmental impact their value proposition has, the more economic growth is achieved, which speaks for an economic activity being decoupling of environmental impact (UNEP, 2011; Kjaer, et al., 2018), as a shorter transport reduce the environmental impact.

Also, the material resource consumption could be decoupled from economic growth if the excavated material is left at their own terminals. By leaving it at their own terminals the material could substitute raw material within their own production of recycled material. The recycled material is later sold and thereby generates revenue. According to De Angelis (2018), the material is reintegrated downstream into the value chain since secondary material will be used for their own production. The reintegration of secondary material does neither imply a cost for the haulage since it is their material. Otherwise, collecting secondary material into the own production often implies costs (Nußholz, 2018).

Moreover, the haulage collects excavated material from other haulages, which corresponds to an upstream reintegration, which is explained by De Angelis (2018) to occur when the material is collected at their end-of-use. Even in this case, the collection of material rather generates revenue than costs since the cost structure could be adapted after other actors' demand of wanting to discard excavated material. Consequently, as the collection of material generates economic growth it is decoupled from resource consumption, according to the definition of

decoupling by UNEP (2011). Additionally, when the resource flow is closed between end-of-use and production, the circular strategy *closing* is used (Bocken, et al., 2016).

Recycler

The recycler's value proposition is to receive, upgrade, and sell excavated material. The value proposition implies that the material goes through several different recycling processes. Like how the end-of-life process of *recycling* is described by Ellen MacArthur Foundation (2019) as energy-leaking, also the CEO (R) explains that their recycling processes require energy. More precisely it is the machines that operate the processes that require energy. Since the machines require energy, it also constitutes a cost in the form of operating for the recycler. The connection between energy and cost implies that if the recycler wants to decrease their costs, they must use less energy. This shows an example of how an environmental change is done in line with an economic change, which Bocken et al. (2014) explain often is the case with environmental changes.

The recycler's value proposition of both receiving and selling material generates two revenue streams. Therefore, the recyclers capture value several times within their business model. To capture value several times is described by Nußholz (2018) as an example of an element within a circular business model. However, Nußholz (2018) state that value capturing should occur several times during one lifecycle in a circular business model. For the recycler, the value capturing is rather captured at the end of one lifecycle, when collecting the material, and at the beginning of a new lifecycle, when the recycled products are sold, which results in the recycler's having a switched focus from a single-use cycle to several lifecycles. A switched focus to several lifecycles is explained to be achieved by implementing circular strategies (Nußholz, 2018). And by capturing value on both sides of the lifecycle, the recycler closes the loop between post-use and production. Therefore, according to Bocken et al. (2016) definition of *closing,* the recycler's business model contains the circular strategy of closing resource flow.

Moreover, none of the revenue streams requires extracted material since it only regards excavated and recycled material. When economic growth does not require deliberately extracted assets the value capture is decoupled from resource consumption (UNEP, 2011). However, the fact that the recycler only has one facility could generate long transports for customers and thereby have a negative environmental impact because of the emission the transports generate. Consequently, customers of the recyclers generate more emissions by using the recycler's value proposition than a value proposition that implies shorter transport. Therefore, there is indirectly a coupling between an environmental impact and the recycler's economic growth. The distance between the customers and the recycler's facility does also cause a rebound effect for the customers, which could be avoided if the recycler had several scattered facilities. The CEO (R) says that they aspire to establish new facilities, but it will require large investments. Ellegaard et al. (2014) state that new investments in resources and technology are enabled by value capturing. Based on that, the preconditions for making new investments can be assumed good for the recycler as they capture value two times within their business models.

However, having a focus on several life cycles within a business model could result in cost in some lifecycles (Nußholz, 2018). For instance, the lifecycle of collecting material often results in costs while other lifecycles will reduce costs, for instance when substituting raw material with secondary material (Nußholz, 2018). However, in the studied case, the collection of materials generates revenue streams for the recyclers instead of causing costs. Moreover, substituting raw materials with secondary does not reduce any larger costs since the raw material already has a low price due to the large resources.

Waste management

Within waste management, the key revenue stream, and therefore the value capturing, is the collection of excavated materials. Since it does not require any deliberately extracted natural assets the economic growth is decoupled from resource consumption (UNEP, 2011). However, the value capturing does generate waste. It follows that value capturing opposes a circular economy, which aims to reduce waste generation (Aarikka-Stenroos, et al., 2021).

When excavated materials are sent to the end deposit, neither the material nor energy is kept in a loop, which also the Technical Circular Economy System Diagram (Ellen MacArthur Foundation, 2019) illustrates. However, around half of the collected material is used within internal projects, which according to the Market area Manager (WM) is the reuse of materials, and therefore not becoming a waste. It could be seen as waste management reintegrating material downstream by using secondary material as input for their own production. When the material is reintegrated, it is also kept within the value chain (De Angelis, 2018). However, the Business area Manager (H) believes that the internal projects are probably invented in the object to get rid of waste material that has been collected, rather than constitute a value. From that perspective, the secondary material is not substituting primary material since waste management would not have bought new material for the internal projects. Therefore, the reuse of material could also be seen as a rebound effect where a circular strategy of reusing has been implied but for no value, despite getting rid of the material. Since the material would not have been bought for the projects otherwise, it could be interpreted as the secondary material does not substitute the primary one, which Zink and Geyer (2017) define as a rebound effect.

5.2 A move towards more circular business models

The second part of the analysis compiles the data on the envisioned circularity and examines it through the theoretical framework regarding ecosystem-level perspective, with the object addressing the second research question.

5.2.1 Envisions of moving towards more circular business models

The data on the envision of how to move to more circular business models is presented in Table 6 The industry's circular envisions divided into internal, internal with external requisites, and external measures.. The different envisions are divided into three categories. The first category contains the envisions that relate to the actor’s own business scope’s circularity and therefore in a firm-level dimension. The second category consists of envisions that are grounded within the actor’s own business scope but require an external actor to act or an external factor to occur to achieve circularity internally. Lastly, the third category regards the circular envisions that

surpass the internal business scope and involve the whole, or parts of, the industry. Since the second and third category involves actors from the value network directly or indirectly, the value dimension from the ecosystem-level perspective is applied (Kanda, et al., 2021), and therefore the envisions are regarded as being in an ecosystem-level dimension.

Table 6 The industry's circular envisions divided into internal, internal with external requisites, and external measures.

Business scope	**Internally**	**Internally with external requisites**	**Externally**
Developer	Choose fossil-free alternatives	Considers new factors when planning – must be accepted by N*aturvårdsverket* and L*änsstyrelsen*	
Building contractors	- Increase "Case A" - Buy material that contains recycled - Discuss with *Länsstyrelsen* to create a consensus	Use other industries' materials – require several industries discussing	- Several recycling terminals - Collaborate between projects - Economic incentives missing - legislation hinders circular demand
Supplier	- Offering recycled products - work towards reaching global goals - Use more barges	- Produce more recycled products - limited collection by *Länsstyrelsen* - Allow permissions to put terminals closer to market, where the demand exist	- Keep materials within the same project (BC) or close to - create economic incentives (waste taxes and measurable sustainability, too large rock resources) - Collaborate between projects, limited space at BC, and the market is not there yet - Planning between BC and D - establish a clear direction for what products excavated materials can become - standardized definition for sustainability - change legislation so excavated do not count as waste
Haulage	- Use smaller trucks - Fill retour-transports, even if it requires longer transport sometimes	- More terminals – but no space - Break pattern of thoughts, requires economic incentives	- Collaborate between projects, but timeframes will not match - Economic incentives missing, if even cheaper developers back

		- collaborate with other's terminals	- Developers should request a certain per cent recycled - industry should contain knowledge to developers - legislation hinders circular demand
Recycler	- Offering recycled products - Keep collaborate with project-based transports - open more terminals - Use other industries' materials – product development		- Collaborate between projects, traditional way of using one Haulage - Economic incentives missing - Standardization of getting permissions
Waste management	Increase reuse within internal projects	Refine collected material, planning from BC	- Use other industries' materials - incentives missing, - collaborate between projects

From interpreting the interview data, several envisions of moving towards circularity are found both within the firm's boundaries and surpassing the firm's boundaries. When the concept of business models surpasses the firm's boundaries it is moved to an ecosystem-level perspective (Teece & Linden, 2017). Therefore, it is interpreted that several circular envisions do have an ecosystem-level perspective.

Furthermore, when the actors are envisioning their transition towards a more circular business model within their firms' boundaries it still requires changes or measures in several cases outside the firm's boundaries. For instance, the Market area Manager (WM) envisions how they as waste management could refine rock that occurs in the collected material, however, only if the Building Contractors had better planning. It shows that a move towards a more circular business model for waste management requires a change in the building contractor's business model. Close work with the partners within the value network is often required when implementing a circular strategy (Parida, et al., 2019; Nußholz, 2017). For instance, a circular transition at one firm could imply a new responsibility at another (Parida, et al., 2019; Nußholz, 2017). The circular transition that the waste management wants to achieve would in this case require the building contractor to take on new responsibilities with their planning. Consequently, even when the circularity is envisioned grounded on a firm level the ecosystem level is required since measures are required outside the firm's boundary. In literature, it is stated that the changes that a circular transition requires must change at a system-level (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021). That proves that the focal firm's transition towards a circular business model is based on interdependencies between members of the value network. Since the on both firm- and ecosystem level, are impacted by the industry's value network.

From an external perspective, the Business area Manager (H) believes that transport and thereby emissions would decrease by combining several actors' projects and thereby enabling the use of several actors' terminals. However, some actors think that problems still occur even if several projects collaborate due to the lack of space at the building contractors. Consequently, applying an ecosystem-level dimension does not enhance a transition towards a more circularity in this case, since it still requires changes at the firm level to be achieved. Even if a change towards circularity must be made at a system level, (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021) this case constitutes an example where internal changes could still require to be done before.

On an ecosystem level, several actors regard the legislation as an obstacle to a circular transition. For instance, the Recycling manager (S) demands a clearer direction for which products excavated materials can become. Also, the Business area Manager (H) interprets the legislation as ambiguous regarding what the opportunities are for recycling. Altogether, the Business Area Manager (H) believes that could easily be interpreted as no excavated material is allowed to be recycled due to its ambiguousness. Altogether, the legislation is a factor that impacts the value network's members and limits the possibilities to recycle material within the industry. Several actors state that legislation must change to enable more circularity. To enable circularity, changes must be made beyond the company's boundaries (Nußholz, 2018), which in this case would refer to changing the legislation. According to Arikka-Stenroos et al. (2021) the actor's relationships with each other are crucial for the whole industry's development. Therefore, the value network and management of relations could strengthen the opportunity to develop the industry by achieving a change in legislation than it would be on a firm level.

Several actors from different business scopes request economic incentives to realize a circular transition. Some believe it should be regulated by imposing taxes, while others believe an environmental value must be measured in a way that it can be charged. The demanding economic incentives are something that Bocken et al. (2014) explains by environmental changes only will be done in line with economic changes. However, one of the reasons why the supplier puts recycled products on the market is to work towards society and reach global goals, since they perceive that it is requested from society. That shows a circular incentive that does not have a direct economic incentive, but rather to show an environmental incentive for society. However, a prerequisite for a circular business model is to go beyond the economic dimension and include both an environmental and social dimension (Joyce & Paquin, 2016). Yet, it is only one of the actors within the different business scope that goes beyond the economic dimension and shows an environmental incentive while the other actors within the study claim that they do miss the economic incentives when they envision circularity.

When envisioning a move towards more circularity within the industry both the Sustainability manager (BC) and the Market area Manager (WM) think that the use of materials from other industries, such as house demolition, is an interesting option, especially to achieve resource consumption decoupling. Activities based on a circular economy, such as resource consumption decoupling, can cut across several sectors and markets (Kanda, et al., 2021). If the material management industry explored other markets as potential suppliers but also customers, both the use of extracted material and waste could be decreased. CEO (R) at the recycling facility,

confirms that they do already have customers from other industries, which proves that the circular activity of recycling could cross markets and sectors.

5.2.2 Value network

Considering an ecosystem-level perspective on the concept of a business model, the value network becomes an important dimension to consider (Kanda, et al., 2021; Allee, 2000; Peppard & Rylander, 2006). The data show that a value network is also considered when envisioning the move towards a more circular business model. For instance, the Market area Manager (WM) explains that waste management could offer refined rock material since they have the technique established and demand from customers. However, they as waste management chose not to put any of their own products on the market since it could affect their relations with their customers, who offer the same product on the market. In this case, the value network rather limits the move towards circularity than enhances it, since it hinders value creation to be resource consumption decoupled. The fact that value creation is hindered by the value network rather than strengthened opposes what is stated by Ranta et al. (2020). It is namely stated that the firm needs to acknowledge more and diverse actors and stakeholders for which the firm creates value (Ranta, et al., 2020). In this case, the waste management's value creation is withdrawn by acknowledging actors such as building contractors and haulages.

However, the Market area Manager (WM) envisions that waste management could offer refined rock but only on direct demand from a customer, to avoid risking business relations with the customers, who offer the same products. To make it possible the Market area Manager (WM) states that the customer must have better planning, which constitutes an example of when the value network with good relations between customer and supplier (in this case waste management) would encourage circularity, which Bocken et al. (2014) confirms. Furthermore, it could be interpreted as the Business area Manager (WM) sees an increased risk on demand to take the circular initiative since the business area manager (WM) requests better planning from the customer which assures a demand for refined rock material. It corresponds to what Parida et al. (2019) states about managing the relationships with various stakeholders since the circularity entails increased risks. Therefore, considering the value network by managing the relations with the customers could decrease the risk of low demand.

Furthermore, one of the suppliers values their relationship with the customers by adapting the production to their demand. For instance, by not integrating recycled material in the extracted products to the customers that specifically request to not have any recycled material. Even though it strengthens the relationship within the network, it couples their value creation with resource consumption, which otherwise is not. In the literature, however, it is stated that within a circular economy, the relationships in the value network should be acknowledged and managed (Parida, et al., 2019). In this case, the acknowledgement of business relations constitutes an obstacle to circular economy, rather than encourage circular economy.

The Business area Manager (H) envisions that as a haulage they could become more circular if they had more terminals since that would decrease transport. However, the lack of space makes it difficult to open new terminals, and therefore the Business area Manager (H) believes a better

option would be to combine several actors' projects and thereby enable the use of several actors' terminals. The changes that circular transitions imply must according to Aarikka-Stenroos et al. (2021) change at a system level. One circular change that requires a system-level perspective is to become more resource-efficient (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021). By combining several actors' supply and demand of materials within a closer area, the Business area Manager (H) means that transport would decrease significantly, and thereby resources could be used more efficiently. According to Parida et al. (2019) and Ranta et al. (2020), achieving a circular transition necessitates effective management of relationships with different actors and the recognition of a broader and more diverse range of stakeholders Therefore, by acknowledging more actors and extending the value network, the chance of collaborating between different projects could increase.

However, the CEO (R) has noticed that there is a traditional way of only using one haulage company per project which the CEO (R) believes is a hinder to collaborations between projects. The reason for this, the CEO (R) believes is to cherish the relation to the haulage. The traditional way shows how managing the relationship of value networks rather limits than enhances circularity since it is stopping the initiatives to collaborate between several projects, and thereby decrease transport. Contrarily, Parida et al (2019) state that managing relationships within the value network would enhance circular changes. In this case, its' less loyal relation to one particular haulage would increase circularity since that could imply more collaboration between other closely located projects. However, an actor's relationship with other members is crucial for competitive positioning (Peppard & Rylander, 2006), which could be the reason why only prioritizing the relationship with one haulage. Furthermore, an increased collaboration is an approach to increase the value capturing within the business model (Minerbo, et al., 2021), which can also be an explanation for the traditional way of only working with one haulage per project, if it encourages increased value capturing between both partners. However, the collaboration with one haulage company does limit collaboration between several projects, and the decreased transports that it would imply. Altogether, the increased value capture and competitive position that occurs when only collaborating with one company limits the move towards more circular business models.

However, the Business area Manager (H) states that they as haulage do see collaborating between projects as a solution, which contradicts what the CEO (R) believes. Moreover, the haulage actively chooses to use suppliers outside the corporate group, especially with the purpose of managing the relationship with their customers. Based on that, the relationships within the value network may not be managed enough since different actors are not aware of the other actors' intentions. And to have shared intentions is a crucial factor for an ecosystem to function since it creates interdependencies between the members (Aarikka-Stenroos, et al., 2021; Kanda, et al., 2021). Therefore, there are opportunities to acknowledge the relationships within the value network further, and search out the members' intentions, which may allow more collaboration than expected. However, the haulage company show that they consider their value network within their business model, which gives good conditions for an eventual circular collaboration in which the value network must be considered according to Parida et al. (2019).

When applying an ecosystem-level perspective, The Recycling manager (S) is concerned about their own role, as suppliers within the value network. From an ecosystem-level perspective, the supplier envisions that a best-case scenario for the industry would be if the excavated material circulated within or close to the construction site, through nearby terminals. Accordingly, that would reduce the transport and use of extracted material. However, this would constitute a threat to the suppliers' business since the demand for supply from them would decrease. It is stated that implying circular activities within a firm could require other members of the ecosystem to take on new roles and change their business models as well (Parida, et al., 2019; Nußholz, 2017). If the industry would change and the building contractors would start prioritizing keeping material closer to the construction site, a change in the supplier's business model would be required to not lose competitiveness.

A further reason a change in the supplier's business model could be required is that new revenue flows and cost streams are often generated when loops of material and energy are closed through exchanges within the ecosystem (Kanda, et al., 2021). Consequently, if the building contractor closes the loops of material and energy in new smaller loops, exchanges will be done between other actors, where location is prioritized over the business relation to one specific actor. It follows that more circularity could be achieved within a project when not prioritizing a specific relation to actors within the value network, but rather a closer distance between the project and other actors. If that is the case, the supplier would need to take on a new role or change their business model to stay competitive.

It is stated that a circular transition requires that relationships are managed with various actors and that more diverse actors are acknowledged (Parida, et al., 2019; Ranta, et al., 2020). In this case, if the building contractor acknowledges more and diverse actors with closer locations to the project it would enable shorter transport than only managing one relationship with a specific supplier. It shows that extending the value network to achieve circularity could instead impair relations with singular actors. In

Table 7 below, the different value network factors are compiled and sorted regarding their impact on a move towards more circular business models. Altogether, considering the value network within the business model concept does impact the use of circular strategies. Depending on if the consideration of relations is solely with particular actors or with various actors in a more holistic perspective, the value network could both limit a move towards circular strategies and enhance it.

Table 7 Value network factors that are enhancing or limiting a move towards more circular business models

Value network factors that enhance circularity	**Value network factors that limit circularity**
A stronger value network could enable Waste Management to sell recycled products by decreased risk of low demand, also facilitate requesting a better planning from customer	Waste Management do not put own recycled products on market, due to not affect customer relations

Acknowledging more actors within value network – favors collaboration between different projects	Suppliers adapting production by excluding recycle material, due to customer requests
Explore shared intentions could enhance circular collaboration	Managing particular relations limit collaboration with several actors

6 Conclusion

This chapter summarizes the answer to the thesis's two research questions and discusses the fulfilment of the purpose.

[RQ 1]

- **Which circular strategies are used within the current business models?**

Since the case study includes six different business scopes, several ways of value proposition and capturing have also been identified. Moreover, the use of circular strategies differs within and between the different business scope's business models. For instance, the haulage captures value that is both coupled and decoupled from resource consumption, depending on what material they transport and where it is transported. The analysis emphasizes that there is a balance between keeping the material in loops and decoupling from environmental impact. If the material must be transported a longer distance to be recycled than to waste management, there must be a consideration between recycling or decoupling from environmental impact. Accordingly, the theory of keeping value within the loop of energy given by Ellen MacArthur Foundation (2017) cannot always be achieved at the same time within the industry today since if the energy is kept within the material, by recycling it, it could imply less energy being kept within the transport. Therefore, it is important to have an ecosystem-level perspective since a circular strategy in one business scope could have the opposite effect throughout the whole flow.

The developer is an actor that has considered the value network and thereby fosters several circular strategies when viewing it from an ecosystem level. Since the developer has implemented more strategic planning, they can combine projects by collaborating with several actors which in turn has led to the adoption of various circular strategies, including closing, slowing, and reusing. Moreover, collaborating with several actors presents opportunities for increased value capture, as the developer can select from multiple actors offering the most cost-effective solutions for each specific aspect of the project. Altogether, it shows the importance of considering the value network to both adopt circular strategies and furthermore increase the captured value of the circular business model. However, the building contractor is an actor that succeeds in including several circular strategies on a firm level in one of their value propositions by using the excavated material as "Case A". It could be considered as a step between the prolong and reuse process, and to be closing and slowing depending on whether the excavated material is defined as used or not. Moreover, it narrows the resource flow into the construction site as less material needs to be transported there.

The actors that recycle succeed in capturing value sveral times, by both collecting and selling material. To capture value several times is described as a factor within a circular business model (Nußholz, 2018). Since collecting material generally results in costs, (Nußholz, 2018) the process of recycling within the material management could be considered a large opportunity as both the collecting and selling material generate revenues. However, the collection of

material does also generate revenue for waste management. Consequently, economic growth is coupled with generating waste, which according to Sjöström and Östblom (2010) opposes a circular business model.

[RQ 2]

- **How does the ecosystem-level perspective enhance respectively limit the move towards more circular business models?**

Altogether, the data shows that most of the circular envisions are seen from an ecosystem-level perspective, and therefore it shows the importance of the ecosystem-level perspective when developing circular business models. However, it is observed that the value network, which includes relationships with customers and stakeholders (Allee, 2000; Parida, et al., 2019), can either enhance or limit the move towards more circular business models. On the one hand, there are instances where waste management companies choose not to put their own products on the market to avoid conflicts with their own customers. This indicates that the value network can limit the move towards more circularity, as it hinders the decoupling of resource consumption and other circular strategies. On the other hand, there are envisions of collaborating between different projects to be able to decrease material resources and transport where acknowledging several actors would be necessary. In this case, a broader value network would support circular initiatives, indicating that collaborative relationships can foster circularity within the industry. Altogether, considering the value network could both enhance and limit the opportunities for circularity. However, when focusing on collaborations and managing relations with various actors, rather than particular members of the value network, the move towards more circular business models is enhanced.

At the same time, a majority of the envisions for more circular business models are based on changes outside the firms' boundaries, and therefore at an ecosystem level, several factors of the value network turned out to be limiting for a move towards more circular business models. Therefore, it is difficult to conclude whether the ecosystem-level perspective enhances or limits the move towards more circular business models. Instead, it shows that on the one hand, most of the circular opportunities are seen from an ecosystem-level perspective by the industry, with collaborations between projects and members of the value network. On the other hand, it shows that a move towards circularity is often considered to be limited, or requiring actions being taken, by other actors or factors within the value network.

In summary, this analysis underscores the significance of the value network in both enabling and limiting circularity within the material management industry in Sweden. It emphasizes the need to obtain an ecosystem-level perspective and consider the value network dimension, not only by managing relations with particular actors but with various actors from different business scopes.

Purpose

"The purpose is to explore the possibilities of moving towards more circular business models within Swedish rock and soil material management with an ecosystem-level perspective.

Within the material management industry in Sweden, there are business models with value capturings and propositions that are both coupled and decoupled with resources or contain more or less value within loops. Moreover, some of the business scope's business models are closed, slowed, and narrowed while others are not. Accordingly, it is proved that circular strategies are established within the material management industry. However, other factors are hindering the circular strategies within the business models to expand, which causes the low percentage of recycling within the industry. A distinctive factor is that several actors' business models are impacted by particular business relations, which in several ways limit the move towards using more circular strategies within the business models. Yet when envisioning circularity, it is often from an ecosystem-level perspective since they consider collaboration between different projects and members within the value network as a solution. Additionally, the literature confirms several opportunities for how value networks could increase the circularity within material management, for instance by decreasing risks and sharing circular intentions. Accordingly, the ecosystem-level perspective could limit circular strategies when only managing relations with particular actors but at the same time enhance circularity when envisioning collaborations between projects in the future. To surmount the gap between a limiting value network, where only particular relations are managed, and an enhancing value network, where collaborations could occur between projects, the members should acknowledge and manage relations with various actors.

7 Discussion

This chapter presents the knowledge contribution from the thesis findings and suggests further studies for the case.

7.1 Knowledge contribution

This thesis has a key focus on business models when exploring the move towards more circular business models. In that way, it differs from earlier studies within material management, which rather have had an environmental or technical approach to circularity. Since the result finds several enhances and limitations on circularity within different business model dimensions, the chosen focus contributes to new findings.

Moreover, the value network could both enhance and limit the industry's move towards more circular business models. However, it could be stated that when only managing relations with particular members of the network it often limits the use of circular strategies within the business model. However, if relations are considered over the whole network, and allowing collaborations between several actors, the value network would enhance the use of circular strategies.

7.2 Future studies

Based on this thesis contribution there are several other relevant subjects to study further within the area. For instance, several interviewees brought up the knowledge gap between the industry and the authorities that regulate it. Moreover, the gap between theory and practice within the industry was mentioned as a limitation of circularity. Therefore, a future subject to study circularity within the same industry would be knowledge sharing and knowledge creation since this could be a crucial part of the industry to realize a circular transition.

Furthermore, as this thesis only studies two of the three value dimensions connected to the firm-level concept of business model, studies could be done further on the third value dimension – value creation. Furthermore, several circular strategies are not examined in this thesis. Therefore, the material management industry could further be studied from other definitions of circular economy, such as the three circular principles or the ReSolve framework. Moreover, it is crucial to examine the take-back, policies that enable recycling. A factor that complicates the take-back policy is the regulations by authorities today, which makes enabling take-back within the industry crucial.

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Appendix A: Interview guides

Inledande del

- Beskriv din roll på företaget, vilka arbetsuppgifter innebär den?
- Beskriv kort kring massornas flöde in och ut till och från er, var kommer de ifrån? Var transporteras de?

Del 1. Affärsmodell och nätverk

- Vilka är era främsta kostnader och intäkter kopplade till masshantering?
- Vilka är era erbjudanden kopplade till masshantering?
- Vilka är era främsta kundgrupper och leverantörer?
- Vilka aktörer är ni beroende av för er verksamhet av masshantering?
- Hur värnar ni om relationerna till de andra aktörer i ert nätverk?
- Hur har nätverket/aktörerna ni arbetar med förändrats med tiden?

Del 2. Cirkularitet

- Upplever ni att efterfrågan på material har ändrats? / Hur stor andel av massorna ni använder är återvunna idag? / Hur stor del av massorna som schaktas lämnas till återvinning?
- Hur tas återvinning i aspekt under planeringen? Ställs några krav idag på återvunna massor/deponering i upphandlingen?
- Vilka incitament finns/saknas det att ta in återvunna/återvinna massor?
- Vilka faktorer anser ni behöver utvecklas internt för att er återvinning ska kunna skalas upp/transporter ska minska?
- Vilka faktorer anser ni behöver ändras inom hela industrin för att er återvinning ska kunna skalas upp?
- Hur hade er verksamhet sett idag om det inte längre bröts något nytt material? Hur hade ni behövt ändra verksamheten om så var fallet?