

# Inter-firm networks and glocalization in realizing a circular economy in the construction sector.

A case study on the Dutch concrete industry



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## Abstract

In recent years, more and more attention has been paid to the wasteful use of raw materials, which leads to major nature and environmental problems. To address these issues, initiatives have been shown by all kinds of stakeholders, in the form of agreements, legislation and action plans, for a transition to a circular economy (CE). This transition is crucial, especially in the construction sector, due to the high level of waste and the use of raw materials. Literature review shows that localization can create local jobs and economic incentives, but also non-economic motives, such as inclusion and engagement. On the other hand, supply chains, business relationships and sales markets have actually been scaled up to a global level in recent decades. Therefore, a shift to a local approach is needed as well as a shift to a supra-national approach to facilitate the CE. Although this may seem paradoxical at first, this process is also known in the literature as 'glocalization'. Much research has been done on CE on multiple scales, however there is insufficient knowledge about the various components addressed by the concept of 'glocalization', especially on inter-firm networks and how they deal with the paradox of glocalization in realizing a CE in the construction sector. The aim of this research is to shed light on how inter-firm networks, which consist of multiple types of business relationships, deal with shifts that take place in the field of institutional and regulatory arrangements and economic activities both to the supra-national and local scale. The research is done through literature research, which provides qualitative, and a case study on the concrete industry, which also provides qualitative data. The case study was investigated through semi-structured interviews, after which these were analyzed using coding tools. On this basis, the paradoxes of glocalization have been formulated and it has been analyzed how the companies and organizations within the inter-firm networks deal with these paradoxes. Although the research shows several limitations with regard to the data and synthesis, it can be concluded that the inter-firm networks exhibit different attitudes, which can be categorized as proactive, reactive and inert, towards the paradoxes of glocalization. Furthermore, the research shows that different attitudes to the paradoxes of glocalization can drive changes in the inter-firm networks, such as business expansions, new partnerships between companies that have similar activities, and new partnerships between companies that have different activities but are working on one resulting product.

**Keywords:** inter-firm networks, glocalization, circular economy, construction sector

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# 1. Introduction

## 1.1. Introduction of the research

In recent years, more and more attention has been paid to the wasteful use of raw materials, which leads to major nature and environmental problems. Examples of this wasteful approach are unsustainable mining and resource depletion, high energy demand for raw material processing, and unsustainable waste processing. To address these issues, initiatives have been shown by all kinds of stakeholders, in the form of agreements, legislation and action plans, for a transition to a circular economy (CE) (Hanemaaijer et al., 2021). The Paris Agreement is an important example of a global approach to counter unsustainable practices. To achieve this agreement, which aims to mitigate climate change, among other things, the shift to a CE is mentioned as an essential part (UNFCCC, 2021). Another example of a large-scale approach is the Circular Economy Action Plan (CEAP), which was adopted by the European Commission in 2020. It introduces initiatives that can promote the CE where an EU-wide approach is advantageous (European Commission, 2020). At a national level, the Netherlands itself is also working towards a CE. The government-wide Circular Economy program was introduced in 2016, which sets out the steps in which the government wants to achieve a CE before 2050 (Rijksoverheid, 2016).

There are also geopolitical motives for a transition to a CE. European countries have a high import dependency on raw materials, such as rare metals, which are extracted and refined by countries such as China. When the demand for raw materials rises, or when a certain scarcity occurs, their prices can fluctuate and supply risks can arise. With a high dependency, this has a negative effect on the economy. The export of waste from high-wage countries to low-wage countries is also growing. This also shifts the negative environmental effects to these low-wage countries, which can lead to certain (ethical) discussions (Hanemaaijer et al., 2021).

One of the most important sectors in which the transition to a CE must be realized is the construction sector. This is apparent from both the CEAP, which points out that the construction sector in the EU is responsible for 35% of all waste (European Commission, 2020), and Dutch documents in which the construction sector receives a lot of attention (Rijksoverheid, 2016; Gemeente Amsterdam, 2020). After all, the Dutch construction sector is responsible for 33% of national waste (Hanemaaijer et al., 2021) and has the largest use of raw materials among all sectors. Better reuse, refurbishment and recycling of materials in this sector can increase the total circularity of the Netherlands from 24.5% to 37% (Circle Economy, 2020). Achieving a CE in the construction sector is complex, because it has a peculiar dynamic of its raw materials. Buildings are often used for decades and at the same time there is a high demand, such as homes in the Netherlands. As a result, there are not enough secondary materials available within the sector. New solutions are therefore needed, such as the use of waste streams from other sectors (Hanemaaijer et al., 2021).

The previous paragraphs have introduced why there is a demand for a CE. While the concept of CE has been around for longer, and shows similarities to concepts like Cradle to Cradle, the following definition, widely used by industry, academics and policymakers, has been given by the Ellen MacArthur Foundation (EMF): “A *Circular Economy* is an economic and industrial system where material loops are closed and slowed and value creation is aimed for at every chain in the system”(Leising et al., 2018). This definition is also adopted for CE in this thesis.

## 1.2. Localization

As mentioned briefly above, CE shows similarities with several other concepts. For example, the concepts Performance Economy, The Blue Economy, Regenerative Design and Cradle to Cradle have similarities in the field of value creation, especially during the design phase, and closing material loops. In realizing these concepts, a local approach is necessary for various reasons. Localization can create local jobs and economic incentives, which is in line with current thinking on CE by policy makers and companies. Non-economic motives, such as inclusion, engagement and participation are also important factors for forming sustainable communities within which the CE can be facilitated (Clube & Tennant, 2020). The idea that localization is necessary for a CE raises the question of how cities will adopt the CE and what the role of cities will be in the transition. In cities it is often possible to experiment with alternative governance and services, which creates many possibilities. For example, cities can take on a role as facilitator, broker or sponsor of activities such as waste management, urban mining or services related to the sharing economy. Bringing parties together and communicating ambitions across a broad spectrum of actors, including consumers, is seen as a task in which cities can play a role (Fratini et al., 2019). It is also recognized at the national level that regional policy is crucial to bring parties together and share knowledge to achieve the CE (Hanemaaijer et al., 2021). What role the city takes on and how it governs depends on a variety of aspects such as scope, industry and actors involved. Although cities can have a lot of influence on the progress of the CE, care must also be taken that its position does not become too dominant. Otherwise, companies and initiatives of NGOs will not be able to compete with the cities (Palm & Bocken, 2021).

To give a better picture of how cities can play a role in the CE, the municipality of Amsterdam can be looked at as an example. There are several reasons why Amsterdam is interesting to study in more detail, such as the size of the city and its economic importance, but more importantly, the city has chosen the CE to drive and shape urban transformation. In essence, the municipality's goal is to localize resource flows and minimize imports in order to be independent of global markets. To achieve this, new products, logistics models and regional and local distribution are needed (Fratini et al., 2019). To make these goals concrete, the municipality has launched several agendas, such as the Sustainability Agenda in 2015, Circular Innovation Program and Learning by Doing in 2016. With the Circular Innovation Programme, the municipality steered market parties to be innovative, whereby the municipality mainly took on a facilitating role, and to a lesser extent a sponsoring role. The Learning by Doing program is particularly interesting because it contains 20 projects in which the municipality uses its commissioning and planning power to drive innovation. With this, the municipality shows the market that circular developments can be profitable. One of the resulting projects was the City Circle Scan, which monitors resource flows. This scan showed that two value chains showed a lot of potential to create loops, namely the construction sector and the biomass sector. Better reuse and recycling in the construction sector shows a potential of €85 million annually and 700 new jobs. However, this is based on the situation that potential producers and consumers have to settle within the city region in order to make the loops cost-effective (Williams, 2021). This strategy to reintroduce manufacturing in cities is also known in the literature as "urban manufacturing" (Tsui et al., 2021).

A more recent document is the Amsterdam Circular 2020-2025 Strategy. Three sectors are discussed, namely food and organic residual flows, consumer goods and the built environment. Here too, the municipality is continuing its ambitions to be more independent from imports and to close waste flows and (re)manufacture locally. Three main ambitions are formulated for the construction sector. Firstly, the municipality wants to integrate circularity more into current and future construction

projects, for example by tightening the Environmental Performance Buildings ('MilieuPrestatie Gebouwen' in Dutch). Secondly, the municipality's ambition is to tender innovatively based on circularity in its own commissioning of public spaces and its own facilities. Finally, the ambition is set to collaborate with third parties to promote CE in the city. The strategy mentions various means such as policy, regulations, knowledge sharing, advice, economic frameworks and direct economic support to achieve various desired sub-ambitions. Despite the fact that the municipality can deploy various means, it is also mentioned that the responsibility of the municipality ends at a certain point. This has to do with the fact that municipal, national and European policy otherwise becomes an accumulation, which causes confusion for the manufacturer, who often wants to sell its products on the largest possible market (Gemeente Amsterdam, 2020).

### 1.3. Globalization

Despite the great focus on localizing the CE, it should not be forgotten that supply chains, business relationships and sales markets have actually been scaled up to a global level in recent decades. As a result, interest has also grown in incorporating CE into business strategies globally (Berardi & Brito, 2021). Policymakers are also aware that it is necessary to take a critical look at how this should be dealt with. That is why, for example, the province of South Holland has initiated a scenario analysis into the macroeconomic consequences of a CE on a local and global scale. The province has two important production centers that are important on a global level, namely Westland and the port of Rotterdam. Westland is a municipality in South Holland that is known for its greenhouses where large food producers are active. The port of Rotterdam is both a major producer of (petro)chemical products and a port where products go to and come from other large parts of Europe. The research shows that a focus on a local CE, both in economic and employment terms, shows a contraction compared to the expected development based on historical data. A focus on global CE however shows growth in these areas (Streng et al., 2018). Although this research addresses important consequences of the localization of CE, it cannot in itself provide a guideline for the province, because it does not study important aspects of CE such as environmental effects and geopolitical motivations.

At the moment, the leaders in the field of CE in Europe are Germany, Belgium, Spain, France, Italy, United Kingdom and the Netherlands. The other countries within the EU-28 are lagging behind, causing a "two-speed Europe" in the field of CE (Mazur-Wierzbicka, 2021). This is a well-known phenomenon in Europe, because part of the European model is that leading member states lead the innovation and the associated policy, after which the Cohesion Policy facilitates developments in less advanced regions with the help of funding (McDowall et al., 2017). As one of the frontrunners of the CE, the Netherlands now also has an interest in European policy for requirements for product design in the field of reparability and use of raw materials. This will create a level playing field between the countries, which will also promote trade (Hanemaaijer et al., 2021). The lack of a European policy will mean that the Member States themselves will have to introduce national policy, for example regarding End-of-Waste (EoW) criteria. EoW criteria are particularly important, because they determine when a waste product is no longer considered waste but as a secondary product or raw material. When national policies do not match, or are even missing altogether, some products cannot be sold on the EU market (Urban Agenda for the EU, 2020).

When it comes to CE in the construction sector, manufacturers of building materials are an important link. In order to gain an insight into how a manufacturer can market a circular product, what its supply chain looks like and what complications this entails, a short informal inventory was made at a

Dutch window frames company, which produces the frames from 100% recycled plastic. This interview was recorded on November 18, 2021, after verbal consent, and has been transcribed verbatim for reference purposes. The interview was mainly exploratory. An interesting part of the interview was about the supply chain, interdependence and choosing local or international partners. The company uses plastic window frame profiles produced by a major German manufacturer, making it a suitable case to analyze why the company has chosen an international partner and whether localization is possible. The interviewees indicated that it is difficult within their sector to switch partners because the machines and processes that are tailored to the specific products. They also mention that despite their preference for local or Dutch producers, it is not always possible to choose such a partner due to the quality or stability. The mentioned stability here is about the fact that the company wants to be sure that they can always get materials. This sometimes means that they have to choose a large supplier, so that they also have room to grow themselves, even if this supplier is not located in the Netherlands or the region. As they also indicated, this can sometimes lead to a power asymmetry (Personal communication, November 18, 2021).

#### 1.4. Problem statement

The previous sections have illustrated how a shift to a local approach is needed as well as a shift to a supra-national approach to facilitate the CE. Although this may seem paradoxical at first, this process is also known in the literature as 'glocalization'. The concept's origins come from Japan where it was used as a business strategy. The introduction of the concept into Western literature was made by Professor Roland Robertson in the 1990s in the field of sociology (Khondker, 2004). For this thesis, however, Erik Swyngedouw's definition is used for clarity and comprehensiveness. The definition given is as follows: "*Glocalisation' refers to the twin process whereby, firstly, institutional/regulatory arrangements shift from the national scale both upwards to supra-national or global scales and downwards to the scale of the individual body or to local, urban or regional configurations and, secondly, economic activities and inter-firm networks are becoming simultaneously more localised/regionalised and transnational.*" An important component of this definition is that 'scale' is something that is produced and modifiable. Reorganizing scales is seen as part of social strategies and an attempt at control and power (Swyngedouw, 2004). Much research has been done on CE on multiple scales, however there is insufficient knowledge about the various components addressed by the concept of 'glocalization', especially inter-firm networks. The three different components of glocalization will be discussed in Chapter 2.

#### 1.5. Research questions

Following the formulated research gap, the following main question was formulated: "*How do inter-firm networks deal with the paradox of glocalization in realizing a circular economy in the construction sector?*"

In order to answer this main question, the following sub-questions will be researched:

1. *What is glocalization and how does glocalization relate to the circular economy?*
2. *What are inter-firm networks in the circular economy?*
3. *What are the opportunities and problems of glocalization in realizing a circular economy in the construction sector?*
4. *How do inter-firm networks exploit the opportunities and address the problems of glocalization?*
5. *What are the practical implications for inter-firm networks of a glocalized circular economy?*

## 2. Literature review

### 2.1. Introduction

Following the research questions, this chapter takes a closer look at the three components of glocalization, namely institutional and regulatory arrangements, economic activities and inter-firm networks. In order to further frame the research, however, a case study will first be chosen in section 2.2. Next, literature will be discussed by component of glocalization. First, literature on CE in the construction sector in general will be discussed, followed by case-specific literature. Next, literature will be discussed by component of glocalization. First, literature on CE in the construction sector in general will be discussed, followed by case-specific literature. When discussing the literature, topics will be divided into sub-components per component. These sub-components are useful to keep the information clear and to be able to relate it to each other. It will also be examined whether the literature relates to a global, European, national or local scale. The literature review on institutional and regulatory arrangements and economic activities will be summarized in 2.5 in two matrices. In the last section of Chapter 2, literature related to inter-firm networks will be discussed. It will also be made clear where information is lacking in the literature on this subject. In chapter 4, this subject will be further discussed with case-specific information.

### 2.2. Choosing a case study

As indicated in the previous section, a case study is used in this research. A case study can be chosen for this research in several ways. In order to make the most considered choice possible, several perspectives are taken into account.

The case study should help to shed light on the inter-firm networks within a niche in the construction sector. For example, a specific product or material that is widely used in the sector can be considered. Examples of such a product are, for example, insulation material or windowframes. Materials can be concrete, steel or wood. In order to maintain the relevance of the research, the aim is to choose a material or product that makes or can make a lot of impact with regard to CE. For this it is important to base the choice on data and since the main focus within this research is the Dutch market, Dutch data is considered. During the search for data, it turned out that data is mainly available with regard to material flows and that relatively little data is available about specific products. That is why it was decided to choose a case study based on a material flow.

As mentioned, perspective is very important when judging whether a material is relevant with regard to the CE. In the introduction to this research, a number of reasons were mentioned why the CE is extremely relevant, namely resource depletion, unsustainable waste management, energy inefficiency and geopolitical uncertainties. Based on the demand for materials in new construction, it was decided to conduct further research into concrete, steel and wood. Brick is also a much sought-after material in new construction (Buck Consultants International, 2020), but this has not been further investigated, because information regarding this flow was lacking in some important studies, such as the RVO report by Prins and Hanemaaijer (2022). When choosing the literature for this analysis, it was taken into account whether data is provided on all three materials.

The following table provides an overview of the data found with regard to concrete, steel and wood. Firstly, it was examined to what extent the material flows are represented in waste, on the basis of weight. It should be noted here that sand and gravel were used as separate categories in addition to concrete in the study. Despite the fact that more types of environmental impacts are mentioned in the study, only those that stood out the most were included in the overview. Perhaps the most striking thing here is that the greenhouse gas emissions from concrete are relatively low. A possible explanation for this is given in 2.3, regarding the side-letter of the Concrete Agreement. The demand

for these materials, in units of weight, is particularly relevant with regard to the transport movements. A high percentage in demand can be related to a high number of transport movements as a result of the material in question. This in turn is important with regard to the CO2 emitted by the transport sector. The data shows that the demand for concrete is clearly the largest. In addition to the greenhouse gas emissions from the PBL document, the CO2 footprint per material has also been noted on the basis of a web tool, made by Danish firms specialized in architecture and construction. In line with the data from the PBL, it can also be seen that steel has a large footprint. In order to be able to include the geopolitical conditions in the assessment, the Herfindahl index for imports per material was examined. This index shows the geographical concentration of trade per product or material. An index below 0.15 means it is not concentrated, between 0.15 and 0.25 somewhat concentrated and above 0.25 concentrated. Because the materials concrete, steel and wood are not directly listed in the source table, an average has been taken of the related materials and products mentioned. For example, for concrete this was: *Lime (including for fertilization), cement and manufactured building materials (except glass or clay) = 0.28 & Stone, sand and gravel = 0.28*. The last factor considered when choosing a case study is the emerging innovations in the market. The findings here are not based on a single source, nor are the data necessarily comparable. It is only intended to give an idea of the possible direction of the market for these materials.

Table 1. Overview table of the material analysis (Author).

	Concrete	Steel	Wood	
Dutch consumption, mass	17%	6%	5%	
Environmental impacts, landuse	0%	0%	26%	(Prins & Hanemaaijer, 2022)
Environmental impacts, human toxicity	2%	16%	2%	
Environmental impacts, greenhouse gass emission	3%	10%	2%	
Demanded mass of building materials (in %, total is 212 million tonne)	80%	4%	3%	(Buck Consultants Interantional, 2020)
kg CO2 eq/ kg	0,128	1,12	-1,49	(CINARK, n.d.)
Herfindahlindex import	0,28	0,21	0,12	(Lemmers et al., 2020)
Upcoming innovative processes	Processing concrete to its core ingredients or concrete grafting	Reuse donor steel and build with disassembly in mind	Timber frame construction and CLT (Cross Laminated Timber)	

Although several choices can be made based on all the findings, which can be seen in the overview table, it is chosen to focus on the concrete industry as a case study, because of the high level of waste, demand for the product and import dependence.

### 2.3. Institutional and regulatory arrangements

Both in the example of CE in Amsterdam and in the analysis on an EU-wide approach, it appears that solutions at different levels are needed with regard to institutional and regulatory arrangements. To further clarify this component of glocalization, firstly literature on CE in the construction sector and then literature related to the concrete industry will be discussed. Four sub-components can be indicated according to Stankevičius et al., on which these institutional and regulatory arrangements have an influence, namely; production, consumption, waste management and the market for secondary raw materials (2020). In recent literature a lot of information can be found on a European, national and local scale about all four sub-components. To illustrate this, a summary of an explorative literature analysis on these sub-components is given below.

In the context of production in the construction sector, the Building Decree is an important instrument at national level that can be used to achieve CE targets. For example, the environmental performance requirements (milieuprestatie-eisen in Dutch) can be tightened to promote circular innovation. At the regional level, municipalities can promote innovation even more by creating space for experiments, whereby the Crisis and Recovery Act (Crisis- en herstelwet in Dutch) can be used to deviate from the Building Decree. However, this requires cooperation from the Ministry of the

Interior and Kingdom Relations (Backes & Boeve, 2018). The implementation of the EU environmental management and audit system can also play a role with regard to supra-national policy on production (Stankevičius et al., 2020).

With regard to consumption, leasing of building components in the construction sector is interesting, such as the Philips Pay per Lux service (Hieminga, 2015). Although such services can contribute to a CE, it can be seen that such concepts show complications with the Dutch law on ownership rights (Schut et al., 2016).

The EU mainly wants to stimulate the CE by setting regulatory frameworks with regard to waste management. Although the concept of waste management has undergone many changes over the years in the EU directives, the main idea has remained that waste must be prevented from ending up in landfill and that reuse and recycling must be strived for. Although this is a good aim, the EU guidelines for construction and demolition waste for the Netherlands, Germany, Belgium and the United Kingdom will be irrelevant, due to the already higher recycling rates (Thomas, 2019). An interesting fact in the waste directives, however, is that some formulations, such as adopting the waste hierarchy, for example, leave a lot of room for the member states to show their own initiative (Stankevičius et al., 2020).

The section on an EU-wide approach has already briefly discussed the importance of European guidelines to create a market for secondary raw materials, using, for example, European End-of-Waste criteria (Urban Agenda for the EU, 2020). In order to also encourage the use of secondary materials in construction, mandatory percentages of secondary materials in construction products can also be prescribed from the EU on the basis of the Ecodesign Directive. If these requirements want to be set at national level, this can be done by incorporating them into the Building Decree, if they are necessary to achieve environmental targets and provided care is taken that the obstacles to European trade caused by the requirements remain proportionate (Backes & Boeve, 2018).

This summary illustrates the discussions around institutional and regulatory arrangement, showing that there are multiple solutions to the different problems. Although the influence and necessity of supra-national arrangements is clear, it can also be seen that a lot of space is often given for national and regional arrangements.

The literature search on institutional and regulatory arrangements has been substantially expanded after the choice of a case study. Choosing an industry within the construction sector offers the opportunity to search for documents and to analyze literature in a much more specific and targeted manner. The analyzed literature on the concrete industry consists of reports, agreements, policy documents and descriptions of standards. An interesting result of the literature search is that no literature was found regarding consumption, waste management or market for secondary raw materials related to institutional and regulatory arrangements on a global scale. It was also noticeable that literature regarding production shows that there are many different standards and guidelines on a national scale, in which different actors are involved, such as CROW, TÜV, NEN, Rijkswaterstaat and ProRail. During the research it appeared that the institutional and regulatory arrangements for the concrete industry not only have an impact on the construction sector but also the infrastructure sector. This has to do with the fact that construction materials for the infrastructure sector come from the concrete waste sector. As a result, the construction and infrastructure sector in the field of concrete are linked. Among the sources, the Concrete Agreement (2018 & 2021) is the one that has been used significantly more often. After all, many topics that are relevant are covered within this agreement. In addition, this agreement has also been signed by many different parties, such as public clients, suppliers, construction companies and sympathizers,

which gives it more support as a source. This agreement contains analyzes of the current concrete industry, sets new ambitions with regard to concrete production and sets ambitions for the coming years. The so-called side letter to this agreement is not included in the literature summary matrix. This was chosen because the nature and impact of this side letter is not fully clear. The side letter indicates amendments to the agreement, which is, however, in continuous development. One of those amendments is, for example, the following: "On the basis of the ETS list, it has been established that the CO<sub>2</sub> emissions produced abroad as a result of the burn process do not count for the CO<sub>2</sub> volume in the Netherlands (Van Gijzel, 2018)." This amendment, made in July 2018, may be one reason that the greenhouse gas emission from concrete in PBL's 2022 report is only 3% (Prins & Hanemaaijer, 2022), which was discussed in 2.3.

When the subject of institutional and regulatory arrangements is dealt with in empirical research, in which market parties are involved, the terms legal affairs, policy, standards and compliance can be used to address the various subjects. This will be included in the methodology when preparing the interview questions.

#### 2.4. Economic activities

A relatively large amount of research has been done into economic activities related to CE in the construction sector in general. This component of glocalization is divided into the sub-components subsidies and investments, banking products, financial due diligence and risk evaluation. This subdivision is made on the basis of frequently occurring topics in the literature that form part of economic activities. Relevant literature was found on all scales for almost all components. The literature found regarding economic activities related to the circular economy consists of academic papers, studies published in the form of reports, and government websites.

Part of the literature is an exploration of various financial resources currently on the market, such as banking products, such as growth funds and loan initiatives, or subsidies, such as the DEI+ and the Kansen voor West program. In addition to new banking products, there are also expected changes, such as with regard to supply chain financing. Supply chain financing is a transaction method in which a third party (for example the bank) finances the supplier on behalf of the buyer, after which the buyer pays off the debt with the third party. As companies work together to close loops, financiers must adopt a supply chain mindset as well. This method is mainly beneficial to SMEs, which is why the Dutch government is also trying to encourage this. It can ensure stronger and more transparent relationships between buyer and supplier, which can reduce the risk of resource scarcity in light of the CE. In the future, this transaction method is expected to be extended to earlier stages of the supply chain, maybe even up to the pre-shipment purchase order, which will require even closer collaboration between parties (Hieminga, 2015).

The other part of the literature, which mainly consists of academic papers, consists of analyzes of the current financial world, addresses the problems that are experienced and focuses on possible changes and improvements for the future, which can stimulate the CE. For example, Dewick et al. describes which tools and guidelines are being developed at global and European level (2020). Most of the topics addressed, mainly from academic literature, are related to financial due diligence and risk evaluation. What is striking is that the opportunities that are seen have to do with the properties of CE, such as the flexibility in value proposition or the local character of circular concepts, as described by Toxopeus et al. (2018). The problems that need to be tackled have to do with the fact that CE is relatively new and we don't know everything about it, which means we have to train bankers to understand CE concepts (Toxopeus et al., 2018). One of those new concepts used in CE, for example, is PaaS. PaaS (Product as a Service) is a circular business model, where the customer pays for the use of a product, which is seen as a service, and the supplier remains the owner of the product. This business model presents several economic risks, including the fact that the collateral

value may be limited, because products delivered are not immediately available to the supplier, so the liquidity of the products in service is low. In addition, it can also be seen that legal complications, such as those relating to ownership rights, mentioned in the paragraph on institutional and regulatory arrangements with regards to consumption, can also lead to risks in the economic field. (Bani, 2020).

With regard to literature specifically related to economic activities in the concrete industry, not many additions have been made. This is due to the fact that the subjects that fall under economic activities seem to be treated in the literature from the CE perspective and not CE in the concrete industry. The additions that have been made fall under investments and grants on a national scale. The Roadmap Reuse Concrete Residual Streams discusses the MIA/Vamil list, which is a list of products that have a positive environmental effect, whereby buyers of these products can receive tax benefits. This also includes circular concrete products, whereby it is striking that the benefit for these products has increased in recent years. The same document of the Concrete Agreement also points out that new regulations regarding demolition work, for example requiring work to take place in a closed environment, reduces the capacity to invest in CE of demolition companies.

When the subject of economic activities is treated in the empirical research, in which market parties are involved, terms such as feasibility, financing and financial risks can be used to address the various topics. This will be incorporated into the methodology when preparing the interviews.

## 2.5. Literature summary matrix

As described in the introduction (2.1), all literature on institutional and regulatory arrangements and economic activities, both on the circular economy in the construction sector and in the concrete industry, is summarized in two matrices. The different sub-categories are shown in the columns and the scale levels are shown in the rows. The colors indicate the source of the findings, so you can see at a glance which sources provide information about which sub-categories or scales. For example, it can be seen that Toxopeaus et al. (2018) at a national level discusses almost all subcategories of economic activities and that Dewick et al. (2020) works across the scales and makes findings across all scale levels of economic activities. The matrices for institutional and regulatory arrangements and economic activities are presented on the next two pages.

Regulatory arrangements	Production	Consumption	Waste management	Market for secondary raw materials
Global	<p>Subject: CSC certification Actor(s): Concrete Sustainability Council Description: The CSC certification is a globally applicable concrete certification, which values concrete products based on four categories: management, environment, social and economy. Source: (Concrete Sustainability Council, n.d.)</p>			
	<p>Subject: International Concrete Standards by ISO Actor(s): ISO/TC71 Description: ISO/TC71 produces a large number of international standards for concrete. Source: (NEN, 2022)</p>			
Europe	<p>Subject: EU ECo-management and audit system (EMAS) Actor(s): European Commission Description: The EU Ecolabel is a voluntary label that allows consumers to make choices based on the sustainability of the product, taking into account the environmental impact over the entire life cycle. Source: (European Commissions, n.d.)</p>	<p>Subject: EU Ecolabel Actor(s): European Commission Description: The EU Ecolabel is a voluntary label that allows consumers to make choices based on the sustainability of the product, taking into account the environmental impact over the entire life cycle. Source: (European Commissions, n.d.)</p>	<p>Subject: EU directives on waste management Actor(s): European Commission Description: The EU mainly tries to support the circular economy with waste directives, which must ensure that waste does not go into landfill and that reuse and recycling must be pursued. Source: (Thomas, 2019)</p>	<p>Subject: European End-of-Waste (EoW) criteria Actor(s): European Commission Description: EoW criteria prescribe when a product is no longer seen as waste but as secondary material. A European approach to these criteria is desirable in order to facilitate trade for these secondary materials between the Member States. Source: (Urban Agenda for the EU, 2020)</p>
	<p>Subject: European Concrete Standards by CEN Actor(s): CEN/TC 304 Description: CEN/TC 304 produces European standards for concrete, of which NEN-EN 206-1 is the most important. According to the European concrete standard, it is permitted to replace 30% by volume in the production of new concrete with coarse aggregate from concrete rubble. Source: (NEN, 2022; Betonakkoord, 2022)</p>	<p>Subject: EU Green Public Procurement (GPP) Actor(s): European Commission Description: GPP is an instrument that authorities can use to procure sustainable products and services. This can increase the demand for sustainable products that are resource efficient, durable, recyclable and repairable. Source: (European Commissions, n.d.)</p>	<p>Subject: EU directives on waste hierarchy leave room for interpretation Actor(s): European Commission Description: Important parts in the EU waste directives, for example concerning the adoption of the waste hierarchy by the member states, leave a lot of room for interpretation, which can lead to policies that are not followed. Source: (Stankevičius et al., 2020)</p>	<p>Subject: EU can encourage certain material use via the Ecodesign Directive Actor(s): European Commission Description: By means of the Ecodesign Directive, a percentage of secondary material can be required from the EU in construction products. However, no requirements can be set for total structures. Source: (Backes &amp; Boeve, 2018)</p>
National	<p>Subject: Building Decree, environmental performance requirements Actor(s): Rijksoverheid Description: The environmental performance requirement (milieuprestatie-eis) in the Building Decree can be tightened to promote circular innovation by lowering the requirement of 1 EUR per square meter of environmental performance in Article 5.9. Source: (Backes &amp; Boeve, 2018)</p>	<p>Subject: Dutch law on ownership rights Actor(s): Rijksoverheid Description: Some circular business models use leasing as a way of selling a product, where the producer retains ownership of the product, leaving responsibility with the producer. However, this has complications with Dutch law on ownership rights. Source: (Schul, et al., 2016)</p>	<p>Subject: BRL SVMS-007 and Verificatieregeling Circular Slooproject1 (Verification scheme Circular Demolition Projects) Actor(s): SIRM Description: The BRL SVMS-007 and Verificatieregeling Circular Slooproject serve as guidelines for demolition contractors and clients to implement circularity in demolition projects, especially with regard to selective demolition and sale of concrete rubble for high-value use. Source: (Betonakkoord, 2021)</p>	<p>Subject: Standard RAW Bepaling (Standard RAW Determination) Actor(s): CROW Description: The Standard RAW Bepaling prescribes that 45-50% of the concrete in road construction must consist of mixed granulate. The consequence of this regulation is that a large part of released mixed granulate is used in this way and does not find its way to the concrete sector. Source: (Betonakkoord, 2021)</p>
	<p>Subject: Commitment to adjust guidelines Actor(s): All parties that have signed the Concrete Agreement Description: All parties will endeavor to adapt calculations such as the MKI and MPG and guidelines such as the CUR recommendations, NEN standards, assessment guidelines and other standards, and technical regulations in such a way that circularity is better integrated and can be stimulated. Source: (Betonakkoord, 2018)</p>	<p>Subject: Extra incentive in addition to the MKI Actor(s): Clients Description: The MKI is not by definition an incentive for reuse and circularity, as a result of which additional incentives may be necessary such as a flat-rate scheme in addition to the MKI, a circularity index and/or a bonus/penalty on top of the MKI based on circular conditions. Source: (Betonakkoord, 2021)</p>	<p>Subject: BRL 2506 part 1 Actor(s): KOMO Description: The roadmap for reuse of concrete residual flows prescribes that clients send released concrete rubble to a location where it can be formed into concrete granulate as aggregate on the basis of BRL 2506 part 1. Source: (Betonakkoord, 2021)</p>	<p>Subject: Requirements on material use can be incorporated in the Building Decree Actor(s): Rijksoverheid Description: Based on the Building Decree, requirements can be set for a building or parts of a building, such as the Foundation, for the use of a certain percentage of secondary material. Such a requirement can only be made if it is necessary to achieve certain goals and if the impediment to European trade is proportionate. Source: (Backes &amp; Boeve, 2018)</p>
	<p>Subject: CUR recommendations that allow higher replacement rates in concrete than EU standards Actor(s): CROW Description: CUR recommendations, produced by CROW, allow higher percentages of concrete aggregate from concrete rubble in new concrete than EU standards, namely 50% and 100%. In the latter case, a recalculation is necessary, if it is of constructive application. Source: (Betonakkoord, 2021)</p>		<p>Subject: Landfill ban on stony materials Actor(s): Rijksoverheid Description: The landfill ban for stony materials has contributed greatly to the use of these materials from demolition in road construction. Source: (Van Merriënboer et al., 2022)</p>	<p>Subject: The price and quality of concrete fractions in the recycling chain is self-directed Actor(s): Demolition companies Description: Whether concrete fractions end up in road construction is mainly self-directed due to the price-quality ratio. The gate fees of recycling companies determine how clean materials are delivered. The purity then determines how the price compares to (the more expensive) gravel. Source: (Van Merriënboer et al., 2022)</p>
	<p>Subject: Preparation of a BRL for the use of fine granulate as a sand substitute Actor(s): TU/e Description: A BRL (certification) is being prepared for the use of fine granulate, obtained from concrete rubble, in concrete as a sand substitute. Source: (Betonakkoord, 2021) Subject: NEN 8005-C1-2017 Actor(s): NEN Description: NEN 8005-C1-2017 is the Dutch interpretation of NEN-EN 206, which deals with the specification, properties, workmanship and conformity of concrete. Other NEN standards for concrete are: NEN 5960:2006, NEN 5970:2001, NEN 5988:1999, NEN 5989:1999 and NEN 2508:1991. Source: (NEN, 2022) Subject: ROK and DVS Actor(s): Rijkswaterstaat and ProRail Description: Rijkswaterstaat and ProRail have drawn up additional guidelines for concrete, namely the ROK and the DVS respectively. Source: (Betonakkoord, 2019)</p>			
Local	<p>Subject: Crisis and Recovery Act Actor(s): Municipalities Description: Municipalities can use the Crisis and Recovery Act (Crisis-en herstelwet) to create room to deviate from the Building Decree, which makes experimentation possible and can promote innovation. Source: (Backes &amp; Boeve, 2018)</p>	<p>Subject: The control of the client Actor(s): Client Description: According to the Concrete Agreement (Betonakkoord), clients must be challenging in their tender regarding the minimum requirements for CO2 reduction and recycled materials. Source: (Betonakkoord, 2018)</p>	<p>Subject: Materiaal en bouw hubs Actor(s): Gemeente Rotterdam Description: The municipality of Rotterdam wants to investigate the opportunities that a materials and construction hub can offer. These hubs facilitate storage, repair and reuse using different waste streams. Source: (Gemeente Rotterdam, 2019)</p>	<p>Subject: Digitale marktplaats Actor(s): Gemeente Rotterdam Description: Linked to the materials and construction hubs, the municipality of Rotterdam is investigating how a digital marketplace can contribute to connecting the supply and demand of secondary (construction) materials. Source: (Gemeente Rotterdam, 2019)</p>
	<p>Subject: 5% concrete residual flows in aggregates Actor(s): Clients Description: Clients, who have signed the Concrete Agreement, agree to have at least 5% of the total volume of aggregates replaced by concrete residual flows in all concrete. Source: (Betonakkoord, 2018)</p>	<p>Subject: The importance of MKI/MPG in tenders Actor(s): Clients and construction companies Description: Clients and construction companies agree in the Concrete Agreement to tender concrete in such a way that the producer or project MKI/MPG decreases steadily. It is also agreed that concrete that meets the MKI/MPG will be valued higher in awards. Source: (Betonakkoord, 2018)</p>	<p>Subject: Material passport Actor(s): Gemeente Rotterdam Description: The Municipality of Rotterdam wants to introduce a material passport together with parties in the city. This will not only be of added value to provide insight into what is used in a building and what the MKI is, but also during the demolition or dismantling of a building. Source: (Gemeente Rotterdam, 2019)</p>	

Source: Backes, C. W., & Boeve, M. N. (2018). Enkele juridische vragen rond een circulaire economie in de bouw.  
Source: Stankevičius, A., et al. (2020). EU waste regulation in the context of the circular economy: peculiarities of interaction.  
Source: Schul, E., Crislaard, M., & Meerman, M. (2016). Circular economy in the Dutch construction sector: A perspective for the market and government.  
Source: Thomas, S. (2019). Law and the circular economy. *Journal of Business Law*, (1), 82-93.  
Source: Urban Agenda for the EU. (2020). Better regulation in a Circular Economy. <https://ec.europa.eu/futurium/en/circular-economy/booklet-better-regulation-circular-economy.html>  
Source: Concrete Sustainability Council (n.d.) What we do. Retrieved from <https://www.concretesustainabilitycouncil.com/what-we-do/>, on April 3, 2022.  
Source: Betonakkoord. (2019, July). Betonakkoord voor Duurzame Groei. [https://www.betonakkoord.nl/public/pages/154652/betonakkoord\\_10\\_juli\\_2019\\_1.pdf](https://www.betonakkoord.nl/public/pages/154652/betonakkoord_10_juli_2019_1.pdf)  
Source: Betonakkoord. (2021, March). Roadmap hergebruik Betonreststromen (Nr. 3). <https://www.betonakkoord.nl/public/pages/165796/roadmap-hergebruik-betonreststromen-03.pdf>  
Source: NEN. (2022). Normcommissie beton. NEN. Retrieved on April 3 2022, from <https://www.nen.nl/normcommissie-beton>.  
Source: Gemeente Rotterdam (2019) Van zool naar moai, Programma Rotterdam Circular 2019-2023. [https://rotterdamcircular.nl/wp-content/uploads/2019/02/27403-41-Programma\\_RdamCircular\\_2019-2023\\_v11-def-in-losse\\_paginas.pdf](https://rotterdamcircular.nl/wp-content/uploads/2019/02/27403-41-Programma_RdamCircular_2019-2023_v11-def-in-losse_paginas.pdf)  
Source: European Commission (n.d.). The Circular Economy Tools and Instruments. Retrieved on April 3 2022, from [https://ec.europa.eu/environment/green-growth/tools-instruments/index\\_en.htm#vetv](https://ec.europa.eu/environment/green-growth/tools-instruments/index_en.htm#vetv).  
Source: Van Merriënboer, S., Bastin, J., Rondelli, A., Rabibio, J. (2022). Kansen voor circulaire bouw hubs in de Provincie Zuid-Holland. TNO 2022 R10423.

Figure 1. Literature review matrix for institutional and regulatory arrangements (Author).

Economic activities	Investments and subsidies	Banking products	Financial due diligence	Risk evaluation
Global	<p>Subject: 20 million dollars in seed capital Actor(s): BlackRock Description: BlackRock launched in 2019 a Circular Economy Fund worth 20 million dollars for seed capital for listed companies. BlackRock gets guidance by IMF and the eligibility of companies is determined by the UN Global Compact. Source: (Dewick et al., 2020)</p> <p>Subject: Looking beyond boundaries of individual firms Actor(s): EMF, World Business Council for Sustainable Development (WBCSD) Description: CE funds and investment decisions should use scientific tools and techniques that take into account nonfinancial aspects. Such an approach, however, is resource intensive. Because of this, EMF and WBCSD have developed circularity measurement tools for companies. Source: (Dewick et al., 2020)</p>	<p>Subject: EUR 750 million sustainable bond Actor(s): Intesa Sanpaolo Description: Intesa Sanpaolo issued a EUR750 million sustainable bond in 2019 allocated to finance businesses with a CE focus through their Pfandfond service. Source: (Zara &amp; Bellardini, 2021)</p>	<p>Subject: Information screening criteria Actor(s): International Platform on Sustainable Finance (IPSF) Description: Technical screening criteria for the circular economy are developed by IPSF. The current classification system focusses on climate change mitigation and adaptation activities. Source: (Dewick et al., 2020)</p>	<p>Subject: Accounting rules should be adapted Actor(s): * Description: "Adapt accounting rules to enable a more representative valuation of circular business models and linear risks." Source: (Ellen MacArthur Foundation, 2020)</p>
	<p>Subject: ERDF Actor(s): European Commission Description: The European Regional Development Fund (ERDF) is a fund which prioritizes innovative and sustainable developments. Source: (European Commission, 2021)</p>	<p>Subject: EUR 10 billion loan and investment initiative Actor(s): European Investment Bank (EIB) in partnership with Europe's five largest national banks Description: The EIB and Europe's five largest national banks and institutions launched a loan and investment initiative of EUR 10 billion for CE activities. Source: (Zara &amp; Bellardini, 2021)</p>	<p>Subject: EU guidelines to contribute to a circular economy Actor(s): EU Expert Group on Circular Economy Financing Description: "The EU Expert Group on Circular Economy Financing is working on a classification of activities deemed to contribute to a circular economy." Source: (Dewick et al., 2020)</p>	
Europe	<p>Subject: The need for public oversight of finance products that are marketed as "sustainable" Actor(s): European Commission, European Securities and Markets Authority (ESMA) Description: The European Commission announced to review the Nonfinancial Reporting Directive and sustainable finance strategy. Also ESMA is noticing the need for public oversight on sustainable finance products. Source: (Dewick et al., 2020)</p>	<p>Subject: EU Action Plan, Financing Sustainable Growth Actor(s): EU Technical Expert Group (TEG) on Sustainable Finance Description: EU's effort to reorient investments towards circular activities. Source: (Dewick et al., 2020)</p>		
	<p>Subject: DEH: Circulaire Economie Actor(s): RVO Description: The DEH (Demonstratie Energie-en Klimaatfinanciering): Circulaire Economie is a subsidy programme of the RVO (Rijksdienst voor Ondernemend Nederland) launched specifically for circular innovation projects. Source: (RVO, 2022)</p>	<p>Subject: Pfandfond, EUR 6 billion credit facility Actor(s): Intesa Sanpaolo Description: A credit facility dedicated to businesses aligned to CE principles, with a focus on Italian SMEs. Source: (Zara &amp; Bellardini, 2021)</p>	<p>Subject: CE eligibility criteria and KPI's Actor(s): Intesa Sanpaolo Innovation Center Description: CE eligibility criteria and KPI's to support screening in the credit process for the Pfandfond service. Source: (Zara &amp; Bellardini, 2021)</p>	<p>Subject: Banks prefer to finance circular companies that are transforming from a linear business model. Actor(s): *Dutch banks* Description: Banks are able to obtain access to more established and secure cash flow when they are financing circular business models of companies that are transforming from a linear one, to de-risk their loans. Existing, larger firms are also more worthwhile for banks than start-ups. Source: (Toxopeus et al., 2018)</p>
National	<p>Subject: Tax benefits following Milieulijst MIA/VAMIL (Environmental List MIA/VAMIL) Actor(s): RVO Description: Every year, the RVO publishes the Environmental List MIA/VAMIL, which indicates the amount of tax benefit for certain investments that have a positive environmental impact. It is striking that the tax benefit for concrete products containing 30% recycled material has been increased from 13.5% in 2021 to 27% in 2022. Source: (Betonakkoord, 2021)</p>	<p>Subject: Bank lending for business model innovation (BMI) is a constraint Actor(s): *Dutch banks* Description: The lack of a track record and specificity of assets make bank lending difficult for BMI. Source: (Toxopeus et al., 2018)</p>	<p>Subject: Including future value of assets Actor(s): *Dutch banks* Description: The future value of assets is important for the bank to include in the value proposition. The contracts with customers and the specific conditions within them, such as opt-out clauses, are decisive for determining the risk on future cash flow. Source: (Toxopeus et al., 2018)</p>	<p>Subject: Partnerships/collaborations in the supply chain can lower risks for banks Actor(s): *Dutch banks* Description: Partnerships/collaborations, by for example sharing ownership of underlying resources, for example through joint ventures, enables inclusion of a larger balance sheet in the risk assessment, resulting in lower risks for banks. Source: (Toxopeus et al., 2018)</p>
	<p>Subject: Obstacles posed by the Environment Act (Omgevingswet) Actor(s): Rijksoverheid and demolition companies Description: The Environment and Planning Act sets new requirements for demolition companies, such as demolition in a "closed space" (from 2022), which requires a substantial investment to adapt the current process. As a result, less can be invested in innovative circular solutions. Source: (Betonakkoord, 2021)</p>	<p>Subject: Supply chain financing Actor(s): *Dutch banks* Description: Supply chain financing is a transaction method in which a third party finances the supplier on behalf of the buyer, after which the buyer pays off the debt with the third party. This transaction method is expected to be extended to earlier stages of the supply chain, which will require even closer collaboration between parties. Source: (Hiemings, 2015)</p>	<p>Subject: Training bankers to understand CE Actor(s): *Dutch banks* Description: There is a need that banks train their relationship bankers to recognize and understand circular BMI. Source: (Toxopeus et al., 2018)</p>	<p>Subject: The importance of contracts for risk assessments Actor(s): *Dutch banks* Description: The duration and opt-out clauses in client contracts affect the perceived risk of future cash flows. "Also, in the case of a buyback construction, the future value of the asset at the end of its (first) use cycle needs to be assessed and compared with the future cash outflow corresponding to the buyback price." Source: (Toxopeus et al., 2018)</p>
			<p>Subject: Credit quality of the customers Actor(s): *Dutch banks* Description: Banks also aim to screen the credit quality of customers to determine whether the service or lease can be paid by the customer. The certainty that the customer can pay for the service reduces the risk of credit default for the borrower. Source: (Toxopeus et al., 2018)</p>	<p>Subject: Flexible value proposition lowers risks Actor(s): *Dutch banks* Description: In the context of circular real estate, a flexible value proposition such as a multipurpose building is of lower risk, because it can appeal to multiple types of markets. Source: (Toxopeus et al., 2018)</p>
			<p>Subject: Circular Economy Finance Guidelines Actor(s): ABN AMRO, ING, Rabobank Description: The three largest banks of the Netherlands, as a part of the FinanCE working group, who aim to facilitate the transition towards a CE, introduced the Circular Economy Finance Guidelines which contain prescriptions on the use of investments, impact assessment, and process evaluation. Source: (Dewick et al., 2020)</p>	<p>Subject: Risk assessment and modelling Actor(s): Central banks and financial regulators Description: "Central banks and financial regulators can integrate circular concepts in risk assessment and modelling, and could explore integrating them in less conventional methods such as green quantitative easing." Source: (Ellen MacArthur Foundation, 2020)</p>
Local	<p>Subject: InnovationQuarter increases access to capital for innovative companies Actor(s): InnovationQuarter Description: "InnovationQuarter is the regional economic development agency for the Province of South-Holland, also known as the greater Rotterdam - The Hague area. InnovationQuarter connects three funds (IQCapital, ENERGIO and UNIQ) with innovative businesses, with, amongst others, a focus on circularity. Source: (InnovationQuarter, n.d.)</p>	<p>Subject: 75 million dollar in growth fund for SMEs Actor(s): Circularity Capital Description: Circularity Capital announced in 2019 a 75 million dollars growth for SMEs that outperform the market. Source: (Dewick et al., 2020)</p>		<p>Subject: De-risking effects of the CE Actor(s): Intesa Sanpaolo Description: Intesa Sanpaolo is working on new risk assessment methodologies, in partnership with Bocconi University, to evaluate the de-risking effects of the CE. This could enable more accurate assessments of benefits of circular practices, which could lead to steering of lending towards circular counterparties. Source: (Zara &amp; Bellardini, 2021)</p>
	<p>Subject: Kansens voor West Actor(s): Provincie Noord-Holland, Zuid-Holland, Utrecht and Flevoland Description: A subsidy programme, which is largely financed by the EU via the EFRO, with the main aim to help innovation in SMEs, carbonfree economy, lowering mismatch on the market and increasing setting environments for companies. Source: (Kansens voor West II, n.d.)</p>			<p>Subject: Embeddedness of a firm within a local community of network Actor(s): *Dutch banks* Description: "(Third.) evidence of embeddedness of a firm within a (local) community or network lowers the perceived risk of default. A firm that is well embedded in a community is less likely to suffer from withdrawal of funds, customers and (local government) support." Source: (Toxopeus et al., 2018)</p>

Source: Zara, C., & Bellardini, L. (2021). The circular economy as a de-risking strategy and driver of superior risk-adjusted returns. *Ellen MacArthur Foundation*.

Source: Toxopeus, H., Achterberg, E., & Polzin, F. (2018). Financing business model innovation: bank lending for firms shifting towards a circular economy. *Sustainable Finance Lab working paper*, Utrecht University, The Netherlands.

Source: Dewick, P., Bengtsson, M., Cohen, M. J., Sarkis, J., & Schröder, P. (2020). Circular economy finance: clear winner or risky proposition? *Journal of Industrial Ecology*, 24 (6), 1192-1200.

Source: Ellen MacArthur Foundation (2020) Financing the circular economy. <https://ellenmacarthurfoundation.org/financing-the-circular-economy-capturing-the-opportunity>

Source: Hiemings (2015, May). Reframing finance in a circular economy. [https://www.ing.nl/media/ING\\_E29\\_Financing-the-Circular-Economy\\_tcm162-84762.pdf](https://www.ing.nl/media/ING_E29_Financing-the-Circular-Economy_tcm162-84762.pdf)

Source: European Commission (2021, June) Regulation (EU) 2021/1058 of the European Parliament and of the Council. *Official Journal of the European Union*. Retrieved on May 29 2022, from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1058>.

Source: RVO (2022, January) DEH: Circulaire Economie. RVO. Retrieved on May 29 2022, from <https://www.rvo.nl/subsidie-en-financieringswijzer/demonstratie-energie-en-klimaatinnovatie-de/circulaire-economie#>

Source: InnovationQuarter (n.d.) Invest & Innovate in the greater Rotterdam - The Hague area. *InnovationQuarter*. Retrieved on May 29 2022, from <https://www.innovationquarter.nl/en/>

Source: Kansens voor West II (n.d.) Programma Kansens voor West II. Kansens voor West II. Retrieved on May 29 2022, from <https://www.kansenvoorwest2.nl/programma/over-kansens-voor-west-2/>

Source: Betonakkoord, (2021, March) Roadmap Hergebruik Betonreststromen (Nr. 3). <https://www.betonakkoord.nl/publicatie/pagina/166796/roadmap-hergebruik-betonreststromen-3.pdf>

Figure 2. Literature review matrix for economic activities (Author).

## 2.6. Inter-firm networks

The third component of glocalization is inter-firm networks. There is no direct definition of the term inter-firm networks in the literature, however, an example is given of how these appear. Embedded firms and strategic alliances are discussed as examples of organizational strategies that occur in regional economies, such as the Randstad, which operate on a local scale but compete internationally. It is being discussed that there is a correlation between glocalization of governance and glocalization of inter-firm networks, whereby the rescaling of regulations, for example with regard to wages and working conditions, can lead to rescaling of inter-firm networks. In the context of Europe, this means that some European regulations open the door to international competition, but also require a sensitivity to sub-national conditions (Swyngedouw, 2004). This is currently also in the construction sector relevant, because trends show that European construction companies are entering foreign markets as a growth strategy. Strategies that are being used to answer the demand for competition in those markets are joint ventures, mergers, acquisitions of local companies and licensing (Butković & Mihić, 2019).

Next to the previously stated relationships between firms that are mentioned as inter-firm networks, supply chains can also be seen as inter-firm networks. Supply chains are defined as: "The network of organizations that are vertically organized into different processes and production activities that create value". The collaborations within these inter-firm networks are especially important for the CE, because it can increase operational performance and be a competitive advantage. However, it should be noted that when choosing partners, the possibility of sharing knowledge and the risk of opportunism must be considered (Berardi & Brito, 2021).

In addition to vertical collaborations, a study on CE in the European polyurethane (PUR) industry shows that horizontal collaborations, which includes collaborations with competitors in the industry, but also further parties such as NGOs and consultancy firms, can promote closing resource loops (Schultz, et al., 2021). This is an interesting observation because, as mentioned in the introduction, the construction sector will also need flows outside industry to become circular (Hanemaaijer et al., 2021). The PUR case is relevant because it is used in many products across different sectors, including construction materials, because it causes major environmental problems and because it still has a lot of potential for a circular transition (Schultz, et al., 2021). The petrochemical industry is also an important sector in the industry of South Holland, based on the disruptive nature of the technology and the use of space, in which, however, it appears that knowledge sharing in the field of sustainability is limited (De Kort et al., 2021).

The literature shows a link between glocalization of governance and inter-firm networks and shows several types of inter-firm networks that are relevant for the CE, also in the construction sector. However, there is a lack of knowledge on inter-firm networks and how they deal with glocalization in order to facilitate a CE in the construction sector. In chapter 3, methods, it will be discussed how this question will be further investigated.

When the subject of inter-firm networks is addressed in the empirical research involving market participants, the terms business model, market, supply chain and collaborations can be used to address the various topics. This will be incorporated into the methodology when preparing the interview questions.

### 3. Methods

#### 3.1. Research method

To answer the main and sub-questions, described in section 1.5, different methods are used to obtain and analyze information. The type of study, methods and techniques, data collection and data analysis are discussed below for each sub-question.

##### 1. *What is glocalization and how does glocalization relate to the circular economy?*

The first part of sub-question 1 has actually already been explored in the introduction under problem statement. The unambiguous definition of a meaning of glocalization, based on literature research, is of great importance in this case, because glocalization is not a concept that is generally known. This is also important in order to be able to relate this research to other research that addresses the concept of glocalization in the future. The starting point for search terms can be found in table 1.

The second part of the literature review is of an exploratory nature. It is examined which shifts upwards and downwards take place in the various components of the concept of 'glocalization', related to the circular economy. This helps relate glocalization to circular economy. However, this part of the literature review is divided into a general part and a case-specific part. It has been decided to take a niche within the construction sector as a case study, in order to be able to delve deeper into the categories of institutional and regulatory arrangements and economic activities. The choice of case is based on literature research and is further explained in chapter 2.2. The literature review consists of several types of sources, such as academic literature, national, supra-national and regional reports and reports from NGOs. Table 1 shows which search terms are used in the search engines to gather the data, at least as a starting point. Both literature reviews will provide qualitative data. The qualitative data, which is mainly text-based, is analyzed by categorizing the data. In this way, connections can be drawn between data obtained from different literature.

Table 2. The starting point for the search terms with regard to sub-question 1.

	Research questions	Google Scholar Search Terms	Other Search Terms (will be used in combinations)
S1	What is glocalization and how does glocalization relate to the circular economy?	("glocalisation" OR "glocalization") AND ("globalisation" OR "globalization") AND ("process") "circular economy" AND ("localisation" OR "localization") // "circular economy" AND ("globalisation" OR "globalization") AND ("circular supply chain management" OR "CSCM")	glocalization // globalization shifts // circular economy // legislation // institutional arrangements // regulatory arrangements // economic activities

##### 2. *What are inter-firm networks in the circular economy?*

The second sub-question will also be answered in the context of the case study. In order to find out what inter-firm networks are in the circular economy, it will first be investigated how the current linear economy functions in the case industry. Subsequently, it will be investigated how circular companies and organizations find their place within this network. Both academic literature and public business documentation will be used for this. The starting point for search terms can be found in table 2. Following this, a mapping will be made of the networks of this case study. This network analysis, the mapping, will serve as a snapshot of the current market. What should and should not be included in the mapping of the network should be apparent from the first part of the research on sub-question 2, but based on the inventories from the introduction, the vertical and horizontal business networks will be considered. It is unlikely that the data to be obtained for this will be fully

publicly available. Therefore, in addition to public sources, empirical data from interviews will also be used to adapt and supplement the initial network analysis. The resulting data will mainly consist of qualitative data and a small portion of quantitative data.

Table 3. The starting point for the search terms with regard to sub-question 2.

	Research questions	Google Scholar Search Terms	Other Search Terms (will be used in combinations)
S2	What are inter-firm networks in the circular economy?	("inter-firm" OR "interfirm") AND ("networks" OR "relations") AND ("built environment" OR "construction sector") AND "circular economy" ("Zuid-Holland" OR "South Holland) AND ("bouwsector" OR "construction sector" OR "gebouwde omgeving" OR "built environment") AND ("bedrijven" OR "companies")	vertical company relations // horizontal company relations // interfirm networks // construction sector marktanalyse // bouwsector Zuid-Holland // SBI-codes // CBS

Within the case study, at least 2 companies must be chosen to collect data about the network. The inter-firm network is expected to consist of several types of companies and organizations, such as demolition companies, construction companies and interest groups. It could provide interesting insights for the research if both comparable and different types of companies can be contacted for the data collection. This would mean that more than 2 companies have to be chosen to achieve this. The qualitative nature of the data that will be collected during the interviews, which will be described below under sub-questions 3 to 5, means that it is not necessary to approach a large number of companies for the data collection.

### 3. What are the opportunities and problems of glocalization in realizing a circular economy in the construction sector?

The third, fourth and fifth sub-questions are designed to find out how the inter-firm networks in the concrete industry experience and respond to glocalization. The data that is obtained for this comes from public interviews and personally conducted in-depth interviews with market parties.

Because the research requires specific knowledge about the organization and the circular economy, the interviewees will be chosen with care. In order to ensure the trustworthiness of the qualitative research, a list of requirements is drawn up that the interviewees must meet, based on the credibility criterion described by Shenton (2004). Below is a preliminary set of requirements.

- Interviewee is familiar with the company structure and the business relationships
- Interviewee is familiar with the circularity activities that the company carries out, both at a (basic) technical level and at a business level
- Interviewee is familiar with the company's circular supply chain management
- Interviewee is familiar with the problems the company faces and the opportunities the company recognizes in relation to the CE.

It is undesirable for jargon or academic terminology to be used in the interview questions to avoid any confusion. Therefore, no direct reference is made to glocalization or shifts that take place with regard to institutional and regulatory arrangements of economic activities in the circular economy. Instead, the interview questions simply refer to compliance and financing, both of which are terms commonly used in the workplace. The interview questions have also been adjusted per sector, to match their activities. Table 3 shows the interview questions for sub-question 3.

Table 4. Interview questions for sub-question 3.

	Interview questions
Demolition company	Which problems did you encounter regarding your compliance in the circular demolition process for concrete?
	Which opportunities did you recognize regarding your compliance in the circular demolition process for concrete?
	Which problems did you encounter regarding your financing for the circular demolition process for concrete?
	Which opportunities did you recognize regarding your financing for the circular demolition process for concrete?
Waste processing company	Which problems did you encounter regarding your compliance in the circular waste processing of concrete?
	Which opportunities did you recognize regarding your compliance in the circular waste processing of concrete?
	Which problems did you encounter regarding your financing for the circular waste processing of concrete?
	Which opportunities did you recognize regarding your financing for the circular waste processing of concrete?
Construction company	Which problems did you encounter regarding your compliance when using circular concrete?
	Which opportunities did you recognize regarding your compliance when using circular concrete?
	Which problems did you encounter regarding your financing when using circular concrete?
	Which opportunities did you recognize regarding your financing when using circular concrete?
Interest-group	Which problems do you recognize regarding the compliance of using circular concrete?
	Which opportunities do you recognize regarding the compliance of using circular concrete?
	Which problems do you recognize regarding the financing of using circular concrete?
	Which opportunities do you recognize regarding the financing of using circular concrete?

4. *How do inter-firm networks exploit the opportunities and address the problems of glocalization?*

Sub-question 4 is a follow-up to sub-question 3 and will also be explored within the same interview. The interview questions formulated in Table 4 are asked after each question in Table 3 and are identical for all companies and organizations.

Table 5. Interview questions for sub-question 4.

	Interview questions
-	How do you address these problems?
-	How do you exploit these opportunities?

5. *What are the practical implications for inter-firm networks of a glocalised circular economy?*

Sub-question 5 is also a follow-up to sub-questions 3 and 4. The interview questions formulated in Table 5 are asked after each question in Table 3 and are identical for all companies and organizations.

Table 6. Interview questions for sub-question 5.

	Interview questions
-	What are the practical implications of these shift for your company?
-	What are the practical implications of these shifts for your network?

As an example, all interview questions intended for a demolition company are listed in the correct order in the following table.

Table 7. Interview questions for a demolition company.

General	1.1	How do you define circular economy?
	1.2	What are the key activities of the organization? // What is the business model of the company (value proposition, main costs and benefits, etc.)?
	1.3	Did the company start as a circular business, or transform from a linear one?
Regulations	2.1	Which problems did you encounter regarding your compliance in the circular demolition process for concrete?
	2.1.1	<i>Nudging questions regarding scale.</i>
	2.2	How did you address these problems?
	2.3	What were the practical implications for your firm and your network?
	2.4	Which opportunities did you recognize regarding your compliance in the circular demolition process for concrete?
	2.4.1	<i>Nudging questions regarding scale.</i>
	2.5	How did you exploit these opportunities?
	2.6	What were the practical implications for your firm and your network?
Economic activities	3.1	Which problems did you encounter regarding your financing for the circular demolition process for concrete?
	3.1.1	<i>Nudging questions regarding scale.</i>
	3.2	How did you address these problems?
	3.3	What were the practical implications for your firm and your network?
	3.4	Which opportunities did you recognize regarding your financing for the circular demolition process for concrete?
	3.4.1	<i>Nudging questions regarding scale.</i>
	3.5	How did you exploit these opportunities?
	3.6	What were the practical implications for your firm and your network?
Inter-firm networks	4.1	What type of relationships does the company have with its supply chain partners?
	4.2	Is the company correctly placed in the network map and are there any relevant actors missing?

As can be seen, general questions have also been included at the beginning of the interview, to get a better idea of what the company's activities are and how they view the circular economy. At the end, questions are also included with regard to inter-firm networks, as mentioned under sub-question 2. The nudging questions are of utmost importance in order to capture the nuances regarding different scales during the conversation. Using these nudging questions requires a lot of attention and spontaneity during the interview.

The data resulting from the interviews will be qualitative. To analyze this data, all interviews will be recorded and transcribed verbatim. Subsequently, the data will be coded in ATLAS.ti to be analyzed in a clear and repeatable way. Different analyzes can be performed with a tool such as the co-occurrence table in the program. A coding based on deduction can be a good basis for analyzing the data and relating it to the literature. However, certain relevant topics may be discussed in the interviews that are not, or to a lesser extent, discussed in the literature, and therefore have not been coded in the first instance. It is therefore possible that (inductive) additions have to be made to the

coding based on the interviews. Prior to the interview, written consent will be requested from the interviewees for conducting the interview, analyzing the data and making it public through the channels of TU Delft. The interviews will be anonymized where necessary.

With the data and knowledge obtained from the research into the sub-questions, the main question can be answered. To repeat, the main question is as follows: *“How do inter-firm networks deal with the paradox of glocalization in realizing a circular economy in the construction sector?”*. Following the literature review on sub-questions 1 and 2, and the analyzes that follow from the interview data related to sub-questions 3, 4 and 5, various connections can be made. First, the literature search, as described earlier, will result in a summary, which will be formatted in a matrix, and an inter-firm network analysis. A database of quotes will be created from the analyzes of the various interviews. Subsequently, the database of quotes will be compared with the literature, from which a comparative matrix will arise. Using all the information from literature and the interviews, the paradoxes of glocalization can then be described in text and possibly in figures. In the last step it will be ensured that the different reactions of companies to the paradoxes are made clear. All these steps can be seen in the figure below.

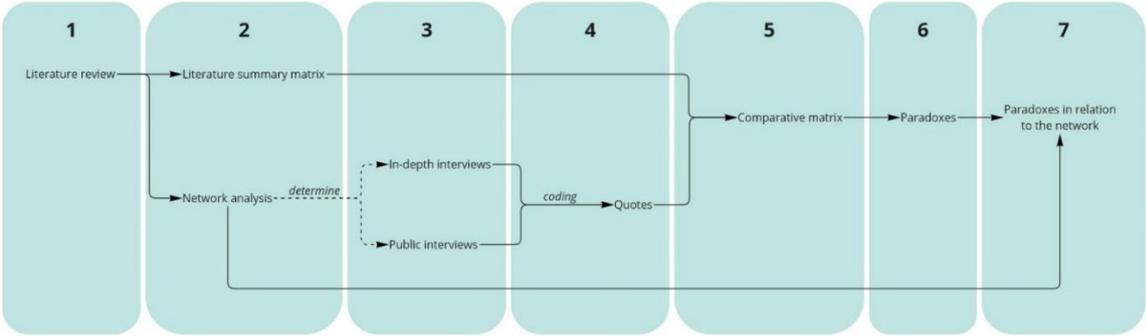


Figure 3. The roadmap of the methodology (Author).

In this research, mainly on the basis of observations, a best prediction is made for an explanation for the research questions, which indicates an abductive method of inquiry. This is appropriate within this thesis, because of its explorative nature. In chapter 6.3 the limitations of this method will be reflected.

### 3.2. Scientific and societal relevance

In 1.4 it was mentioned that research in the field of inter-firm networks in a CE is insufficiently covered in academic literature. Due to the expected new type of collaborations that have to be formed in a CE to use products in a cycle, for example with the help of horizontal collaborations in addition to vertical collaborations, it is becoming more and more relevant to conduct further research into this. In addition, the concept of glocalization is also becoming increasingly important as a result of abrupt shifts that take place. At the moment this can be seen, for example, with regard to the war in Ukraine and all related effects, such as acute price increases of building materials and fuel (Bouwend Nederland, 2022), where an event on a global scale has direct consequences on a national and local scale with regard to economic activities. It is therefore important to understand how inter-firm networks deal with glocalization.

The societal relevance is mainly related to the fact that the ultimate goal of a CE is to leave behind a sustainable environment and economy for current and future generations. A better understanding of how this can be achieved will help public representation, in other words the authorities, to facilitate this as accurately as possible.

## 4. Results

### 4.1. Introduction

In this chapter the results of the study are discussed. In 4.2 the inter-firm networks analysis of the concrete industry is discussed, which was made on the basis of literature research and adapted on the basis of responses during interviews. In 4.3 the interviews that were conducted are discussed, additional information is given on how the interviews have been compared with the literature review from chapter 2 and the new matrices are shown.

### 4.2. Inter-firm network analysis

The inter-firm network analysis that will be explained below is a snapshot, as it were, of the current concrete industry. This analysis helps to better relate the literature to the actors in the network and to be able to relate the empirical research to the network in the following parts. In addition to a general picture, the network analysis also provides a first picture of possible competitions, collaborations, interdependencies and overlapping activities in the concrete industry. It should be mentioned, however, that the companies mentioned in the network map are not directly related to the research, and do not represent the total size of the market. The companies included in the network analysis were chosen following a brief inventory of which parties take into account circularity when demolishing buildings with concrete. This inventory serves, among other things, as a starting point for approaching parties for the empirical research.

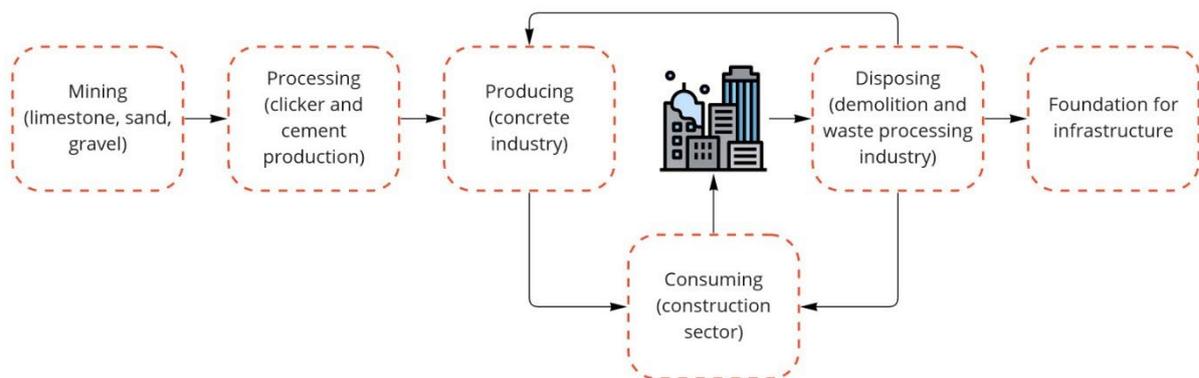


Figure 4. Abstract representation of the concrete industry network (Author).

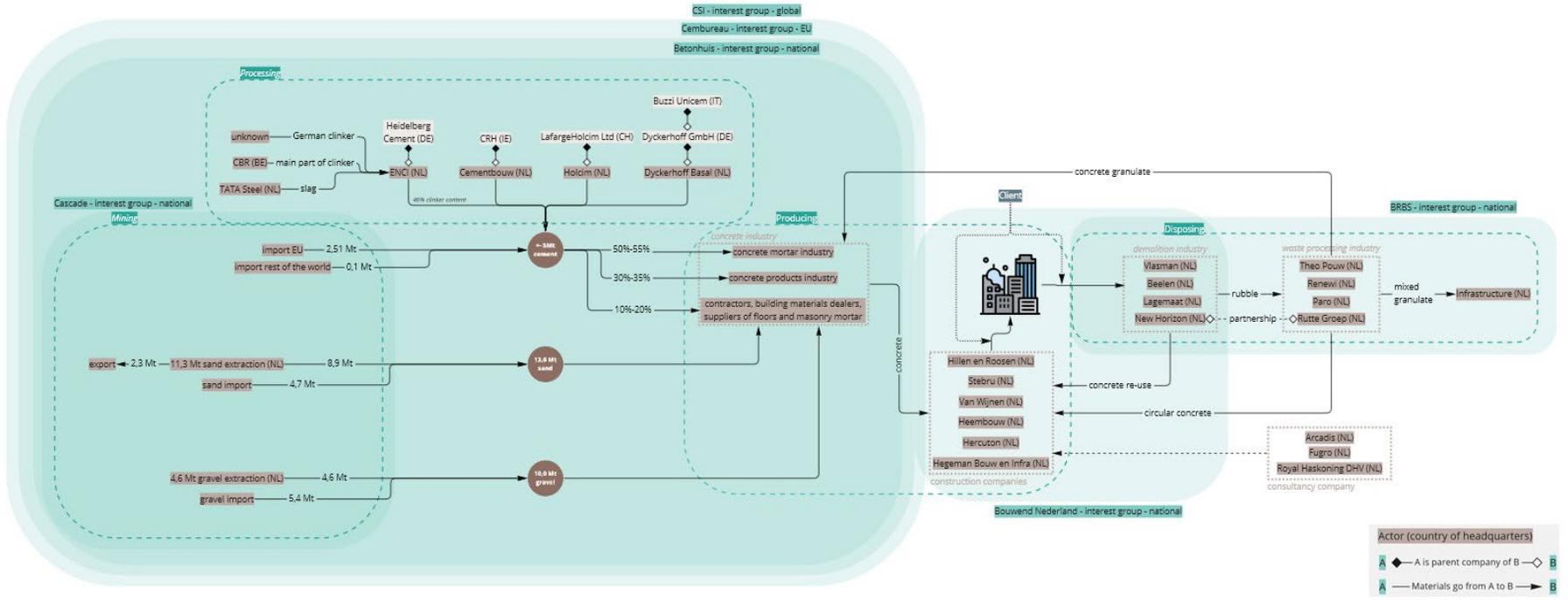
Above is an abstract representation of what the inter-firm network of the concrete industry looks like. At the beginning, raw materials such as limestone, sand and gravel are extracted, part of which is then processed into cement from the limestone, for example. This is then delivered to the concrete industry, which can produce concrete in various ways. This is then purchased by construction companies and ends up in construction works. When a concrete building has to be demolished, the demolition and waste processing industry comes into the picture. They can either process the concrete into new concrete products with concrete manufacturers, or can reuse concrete products or process the concrete for the infrastructure sector.

In the Netherlands, approximately 5Mt of cement is used annually (Betonhuis, 2020). About half of this is imported. Most of the imports come from Europe (CBS, 2020). The part of the cement that is not imported is produced in the Netherlands. However, if we look at the raw materials that are needed for this, it is clear that the clinker, from which cement is made, largely comes from Belgium and Germany. It can also be seen that residual flows such as slag are important for cement

production in the Netherlands (Xavier & Oliviera, 2021). The large cement companies in the Netherlands have been bought over the years by the large international holding companies in the field of cement production, namely Heidelberg Cement (ENCI, n.d.), CRH (Europa Nu, 2003), LafargeHolcim Ltd (Holcim, n.d.), Dyckerhoff GmbH and Buzzi Unicem (Dyckerhoff Basal, n.d.). Sand and gravel is largely extracted in the Netherlands around the river deltas (Cascade, n.d.). It is especially visible that we are largely self-sufficient with regard to sand. Nevertheless, there is still a considerable import flow for both sand and gravel. Cement, sand and gravel eventually end up in the concrete industry (CLO, 2018). Within this, about half of the cement goes to the concrete mortar industry, about a third to the concrete products industry and the remainder to the contracting company, building materials dealers and suppliers of floors and masonry mortar (Betonhuis, 2020). The concrete that is produced is then used by the construction industry in the construction of buildings. In this step, the client of the building plays a major role, as it determines the preconditions for the project, which in turn can determine the use of the type of concrete or alternative material. When a building is demolished, the owner of that building is also influential in the demolition work. After the demolition work has been completed, there may be a flow of concrete products for reuse, which can be reused by construction companies in new projects. A concrete rubble flow is also almost unavoidable. This must then be sent to a waste processing company. The concrete residual flows that arise after their process go either to the concrete industry, or to the infrastructure industry or to construction companies. Interest groups can also be seen in the network analysis. The interesting thing here is that the sectors and industries that some interest groups represent are represented by multiple interest groups.

The map of the inter-firm networks shows that the material flows are drawn from industry to industry, and not from company to company. This is because, except for one, no publicly disclosed collaborations have been found within the concrete industry when looking at CE. The reasons for this are discussed in more detail in the data synthesis. Three loops can also be seen in the inter-firm network analysis, which indicate a CE. The first loop is from the built environment, to the demolition companies, to the construction companies and back into the built environment. This loop can be seen as the reuse, repair, refurbish or remanufacture categories in the R-ladder (Hanemaaijer et al., 2021). Subsequently, a loop can be seen from the built environment, to the demolition companies, through to the waste processing companies, which then produce concrete themselves and deliver it to the construction companies, which then ends up in the built environment. The same loop can also be seen with a slight change, where the waste processing companies do not produce the concrete themselves, but sell the aggregates to the concrete producers, who then supply the concrete to construction companies. These 2 loops can be seen as the recycle category of the R-ladder (Hanemaaijer et al., 2021).

Figure 5. Inter-firm network analysis of the concrete industry (please turn page clockwise) (Author).



Based on the description of inter-firm networks, which can be found in 1.5.3., it is possible to reflect on how they occur in the circular economy. Strategic partnerships and joint ventures can be seen especially in cement production, with large international companies acquiring Dutch companies over the years. In the current form of the network analysis, this is not part of the CE, but the linear economy. A single strategic partnership can be seen between New Horizon and Rutte Groep, who together have set up a circular process for concrete rubble processing. The largest part of the network consists of vertical collaborations. In this, companies work one after the other on the realization of a product. This includes the production of granulates and the collaboration between demolition companies and waste processing companies. Horizontal collaboration is visible in two places in the network. Firstly, it can be seen that part of the processed concrete rubble from the demolition of buildings goes to the infrastructure sector. The fact that the material makes a step between sectors can be seen as a horizontal collaboration. In addition, it can also be seen that there are collaborations between engineering firms and construction companies, which concern the provision of knowledge, which can also be seen as a horizontal collaboration.

### 4.3. Interview data

In this section the results of the interviews are discussed. First, the names of the companies and interviewees are anonymized to ensure privacy. The list of codes can be found in an external document with the naming: Anonymization of the data\_17 May 2022\_Özaltun.docx.

Some interviews were short for practical reasons regarding the availability of the interviewees. Some also lasted shorter because of the level of detail at which the interviewees answered the questions. This may have to do with the open-ended question, which was attempted to be solved by asking nudging questions, or the level of knowledge of the interviewees. In all interviews it was ensured that the interviewees were well acquainted with the activities of the company or organization regarding circular concrete, and the other preconditions mentioned in 2.2.

In total, 4 interviews were conducted from 4 separate companies, with the codes D-C, WP-B, E-A and IG-A, and 4 online interviews were analyzed from 2 separate companies, with the codes D-A and D-B. The codes D stand for demolition companies, WP for waste processing companies, E for engineering firms and IG for interest groups. It should be mentioned that the online data is different and has shortcomings on some points, which are discussed in the limitations. The online data was processed in exactly the same way as the own interviews. After analyzing the online interviews, meetings were attended with the relevant companies, in which the possibility was created to check part of the data. There were no deviating findings during the meetings, after which it was decided to further process the data in the research.

All interviews were transcribed verbatim and translated from Dutch to English using Google Translate. Some corrections have been made to the translations afterwards. All transcripts can be found in an external document with the naming: Interview transcriptions\_17 May 2022\_Özaltun.docx.

As mentioned in 2.2, the ATLAS.ti program was used to analyze the interviews. This is due to the practical properties of the program, such as numbering data in the desired order, applying codes in documents, applying co-occurrence analyzes and making use of various export options. To code the data of the interviews, the sub-categories were used, as described in 3.2. A version has been made of each sub-category with 'problem' and with 'opportunity' added. This is mainly intended to be able to establish a link between the data and sub-questions 3 and 4. This also gives the opportunity to filter the mentioned possibilities and problems in a sub-category faster from the large collection of data and to make it easier to interpret data when used as a reference work.

Table 8. Co-occurrence table of the scales and sub-categories (Author).

	◇ EU	◇ Global	◇ Local	◇ National	
◇ Banking products, opportunity				1	
◇ Banking products, problem				1	
◇ Consumption, opportunity	2		12	19	
◇ Consumption, problem	1	1	5	24	
◇ Financial due diligence, opportunity			5	14	
◇ Financial due diligence, problem			1	6	
◇ Investments and subsidies, opportunity	2	2	11	37	
◇ Investments and subsidies, problem	1	4	4	31	
◇ Market for secondary raw materials, opportunity		1	18	24	
◇ Market for secondary raw materials, problem			11	17	
◇ Production, opportunity			9	21	
◇ Production, problem	2		3	19	
◇ Risk evaluation, opportunity				2	
◇ Risk evaluation, problem					
◇ Waste management, opportunity			24	13	
◇ Waste management, problem		3	22	8	

Above is a table showing the number of quotes coded with the different scales and sub-categories. Although no quantitative conclusions can be drawn on the basis of this qualitative data, this table shows which topics were and were not discussed during the interviews. In particular, it can be seen that the EU and global scale levels have been discussed relatively little.

A total of 380 quotes have been encoded, all of which can be found in Appendix A and Appendix B including the full quotes, the codes and the quote ID.

After coding the interviews, the quotes were compared with the findings from the literature. Since the findings from the literature have been processed in a matrix, it was decided to process the findings from the interviews in a new matrix. This is done by adding a column after each sub-category in the matrix, in which the quote IDs are noted when a quote is related to the literature. For example, it may be that the quote contradicts, attributes, or has an opinion about the findings from the literature. When a statement is made that is not related to the findings from the literature review, but is relevant for a sub-category and scale level, a new description is added to the matrix. Any quotes that subsequently make a related finding about this new description are noted in the adjacent cell.

These matrices which can be seen in figures 6 to 9 will be used in the next chapter for the synthesis. When a topic is discussed in the synthesis, it is possible to look in the matrix to see which quotes are about that topic and it is also possible to analyze which related topics in, for example, another scale say something about this topic. Although the matrix provides an overview of all literature and findings from the interviews, it is important that it is used during the synthesis in combination with

the full quotes in the Appendixes and in some cases also with the interview transcripts to understand the context of the quote.

With regard to economic activities, the matrix shows that there are many new findings with regard to investments and subsidies and financial due diligence on a national scale. It can also be seen that few topics were discussed during the interviews that correspond to the literature. This will be reflected in the discussion. The institutional and regulatory arrangements matrix shows that there are many new findings at national and local level across all sub-categories. In contrast to economic activities, this matrix shows that many topics have been discussed that are also discussed in the literature.

Figure 6. New matrix for institutional and regulatory arrangements, part 1. (please turn page clockwise)(Author).

Regulatory arrangements	Production	Quotes	Consumption	Quotes	Waste management	Quotes	Market for secondary raw materials	Quotes
Global	<p>Subject: CSC certification</p> <p>Actor(s): Concrete Sustainability Council</p> <p>Description: The CSC certification is a globally applicable concrete certification, which values concrete products based on four categories: management, environment, social and economy.</p> <p>Source: (Concrete Sustainability Council, n.d.)</p>		<p>Subject: Trade restrictions</p> <p>Actor(s): -</p> <p>Description: The CE is becoming increasingly relevant as international trade restrictions and crises make the trade and transportation of materials more difficult.</p>	1:2, 1:18, 1:22	<p>Subject: International demolition companies</p> <p>Actor(s): Demolition companies</p> <p>Description: The demolition processes of international demolition companies are different from local demolition companies. This is mainly due to the difference in knowledge about the regulations regarding waste separation.</p>	4:44, 4:45, 4:46		
	<p>Subject: International Concrete Standards by ISO</p> <p>Actor(s): ISO/TC71</p> <p>Description: ISO/TC71 produces a large number of international standards for concrete.</p> <p>Source: (NEN, 2022)</p>							
Europe	<p>Subject: EU ECO-management and audit system (EMAS)</p> <p>Actor(s): European Commission</p> <p>Description: The European ECO-management and audit system is the official European instrument that can help organisations improve their environmental performance. The use of this tool by organizations can promote circular production.</p> <p>Source: (Stankevičius et al., 2020; EU, n.d.)</p>		<p>Subject: EU Ecolabel</p> <p>Actor(s): European Commission</p> <p>Description: The EU Ecolabel is a voluntary label that allows consumers to make choices based on the sustainability of the product, taking into account the environmental impact over the entire life cycle.</p> <p>Source: (EU, n.d.)</p>		<p>Subject: EU directives on waste management</p> <p>Actor(s): European Commission</p> <p>Description: The EU mainly tries to support the circular economy with waste directives, which must ensure that waste does not go into landfill and that reuse and recycling must be pursued.</p> <p>Source: (Thomas, 2019)</p>		<p>Subject: European End-of-Waste (EoW) criteria</p> <p>Actor(s): European Commission</p> <p>Description: EoW criteria prescribe when a product is no longer seen as waste but as secondary material. A European approach to these criteria is desirable in order to facilitate trade for these secondary materials between the Member States.</p> <p>Source: (Urban Agenda for the EU, 2020)</p>	
	<p>Subject: European Concrete Standards by CEN</p> <p>Actor(s): CEN/TC 104</p> <p>Description: CEN/TC 104 produces European standards for concrete, of which NEN-EN 206-1 is the most important. According to the European concrete standard, it is permitted to replace 30% by volume in the production of new concrete with coarse aggregate from concrete rubble.</p> <p>Source: (NEN, 2022; Betonakkoord, 2022)</p>	8:7	<p>Subject: EU Green Public Procurement (GPP)</p> <p>Actor(s): European Commission</p> <p>Description: GPP is an instrument that authorities can use to procure sustainable products and services. This can increase the demand for sustainable products that are resource efficient, durable, recyclable and repairable.</p> <p>Source: (EU, n.d.)</p>		<p>Subject: EU directives on waste hierarchy leave room for interpretation</p> <p>Actor(s): European Commission</p> <p>Description: Important parts in the EU waste directives, for example concerning the adoption of the waste hierarchy by the member states, leave a lot of room for interpretation, which can lead to policies that are not followed.</p> <p>Source: (Stankevičius et al., 2020)</p>		<p>Subject: EU can encourage certain material use via the Ecodesign Directive</p> <p>Actor(s): European Commission</p> <p>Description: By means of the Ecodesign Directive, a percentage of secondary material can be required from the EU in construction products. However, no requirements can be set for total structures.</p> <p>Source: (Backes &amp; Boeve, 2018)</p>	
	<p>Subject: Eurocode</p> <p>Actor(s): Engineering companies</p> <p>Description: The assumption is that products originating before the introduction of the Eurocode do not comply with the current standards, which have been calculated with this code.</p>	6:8	<p>Subject: CE approval</p> <p>Actor(s): EU</p> <p>Description:</p>	6:23, 6:24, 6:25				
National	<p>Subject: Building Decree, environmental performance requirements</p> <p>Actor(s): Rijksoverheid</p> <p>Description: The environmental performance requirement (milieuprestatie-eis) in the Building Decree can be tightened to promote circular innovation by lowering the requirement of €1 per square meter of environmental performance in Article 5.9.</p> <p>Source: (Backes &amp; Boeve, 2018)</p>	1:3, 1:7	<p>Subject: Dutch law on ownership rights</p> <p>Actor(s): Rijksoverheid</p> <p>Description: Some circular business models use leasing as a way of selling a product, where the producer retains ownership of the product, leaving responsibility with the producer. However, this has complications with Dutch law on ownership rights.</p> <p>Source: (Schut et al., 2016)</p>	2:6	<p>Subject: BRL SVMS-007 and Verificatieregeling Circulair Slooproject1 (Verification scheme Circular Demolition Project1)</p> <p>Actor(s): SVMS</p> <p>Description: The BRL SVMS-007 and Verificatieregeling Circulair Slooproject1 serve as guidelines for demolition contractors and clients to implement circularity in demolition projects, especially with regard to selective demolition and sale of concrete rubble for high-value use.</p> <p>Source: (Betonakkoord, 2021)</p>		<p>Subject: Standaard RAW Bepaling (Standard RAW Determination)</p> <p>Actor(s): CROW</p> <p>Description: The Standaard RAW Bepaling prescribes that 45-50% of the concrete in road construction must consist of mixed granulate. The consequence of this regulation is that a large part of released mixed granulate is used in this way and does not find its way to the concrete sector.</p> <p>Source: (Betonakkoord, 2021)</p>	
	<p>Subject: Commitment to adjust guidelines</p> <p>Actor(s): All parties that have signed the Concrete Agreement</p> <p>Description: All parties will endeavor to adapt calculations such as the MKI and MPO and guidelines such as the CUR recommendations, NEN standards, assessment guidelines and other standards and technical regulations in such a way that circularity is better integrated and can be stimulated.</p> <p>Source: (Betonakkoord, 2018)</p>		<p>Subject: Extra incentive in addition to the MKI</p> <p>Actor(s): Clients</p> <p>Description: The MKI is not by definition an incentive for reuse and circularity, as a result of which additional incentives may be necessary such as a flat rate scheme in addition to the MKI, a circularity index and/or a bonus/malus on top of the MKI based on circular conditions.</p> <p>Source: (Betonakkoord, 2021)</p>	3:58, 3:59, 3:60, 3:61, 3:62, 3:63, 3:64, 3:65, 3:67, 3:69, 6:31, 6:34	<p>Subject: BRL 2506 part 1</p> <p>Actor(s): KOMO</p> <p>Description: The roadmap for reuse of concrete residual flows prescribes that clients send released concrete rubble to a location where it can be formed into concrete granulate as aggregate on the basis of BRL 2506 part 1.</p> <p>Source: (Betonakkoord, 2021)</p>		<p>Subject: Requirements on material use can be incorporated in the Building Decree</p> <p>Actor(s): Rijksoverheid</p> <p>Description: Based on the Building Decree, requirements can be set for a building or parts of a building, such as the foundation, for the use of a certain percentage of secondary material. Such a requirement can only be made if it is necessary to achieve certain goals and if the impediment to European trade is proportionate.</p> <p>Source: (Backes &amp; Boeve, 2018)</p>	
	<p>Subject: CUR recommendations that allow higher replacement rates in concrete than EU standards</p> <p>Actor(s): CROW</p> <p>Description: CUR recommendations, produced by CROW, allow higher percentages of concrete aggregate from concrete rubble in new concrete than EU standards, namely 50% and 100%. In the latter case, a recalculation is necessary, if it is of constructive application.</p> <p>Source: (Betonakkoord, 2021)</p>	4:21, 4:24, 4:25, 7:1	<p>Subject: re-use of products</p> <p>Actor(s): Demolition company</p> <p>Description: Some products can be reused immediately after dismantling, but other products have to go through a process to become a usable, certified and guaranteed product again. There are also products, such as asbestos, that may not be reused at all.</p>	1:4, 1:5, 3:1, 4:7, 4:11, 4:37, 5:7, 5:17, 5:18, 5:44, 6:2, 6:3, 6:4, 6:10, 6:17, 6:18, 8:50	<p>Subject: Landfill ban on stony materials</p> <p>Actor(s): Rijksoverheid</p> <p>Description: The landfill ban for stony materials has contributed greatly to the use of these materials from demolition in road construction.</p> <p>Source: (Merliënboer et al., 2022)</p>	3:18, 5:1, 6:16	<p>Subject: The price and quality of concrete fractions in the recycling chain is self-directed</p> <p>Actor(s): Demolition companies</p> <p>Description: Whether concrete fractions end up in road construction is mainly self-directed due to the price-quality ratio. The gate fees of recycling companies determine how clean materials are delivered. The purity then determines how the price compares to the (more expensive) gravel. Source: (Merliënboer et al., 2022)</p>	5:40
	<p>Subject: Preparation of a BRL for the use of fine granulate as a sand substitute</p> <p>Actor(s): TÜV</p> <p>Description: A BRL (certification) is being prepared for the use of fine granulate, obtained from concrete rubble, in concrete as a sand substitute.</p> <p>Source: (Betonakkoord, 2021)</p>		<p>Subject: Designing with secondary materials</p> <p>Actor(s): Demolition company and engineers</p> <p>Description: A better insight into what will be released in materials from buildings can help to better implement it in construction projects.</p>	3:40, 3:41	<p>Subject: Provide insight into material flows from buildings</p> <p>Actor(s): Demolition company</p> <p>Description: The ambition is expressed to provide insight on a national scale which material flows will become available from the built environment, for example from parties with large real estate portfolios.</p>	1:12, 1:14, 3:35, 3:36	<p>Subject: The market for granulates</p> <p>Actor(s): Waste processing company</p> <p>Description: The regulations for mixed granulate are relatively flexible. In addition to concrete, mixed granulate may also contain materials such as brick. However, concrete granulate must be of a higher quality and must not contain other material flows. Considerations are made on the basis of supply and demand in which granulate concrete residual flows are processed.</p>	3:13, 3:14, 3:17, 3:19, 3:20, 4:20, 4:22, 4:23, 5:35, 5:39, 5:41, 8:3, 8:12, 8:13, 8:38, 8:38, 8:55, 8:56
	<p>Subject: NEN 8005+C1:2017</p> <p>Actor(s): NEN</p> <p>Description: NEN 8005+C1:2017 is the Dutch interpretation of NEN-EN 206, which deals with the specification, properties, workmanship and conformity of concrete. Other NEN standards for concrete are: NEN 5960:2006, NEN 5970:2001, NEN 5988:1999, NEN 5989:1999 and NEN 2509:1991.</p> <p>Source: (NEN, 2022)</p>	8:7	<p>Subject: The aim to reduce CO2 consumption</p> <p>Actor(s): Government</p> <p>Description: The government is increasingly demanding lower CO2 consumption. Because Portland cement has a high CO2 footprint, concrete producers are asking how this CO2 consumption will be reduced.</p>	5:11, 5:12, 5:13	<p>Subject: Circular demolition in decision-making process</p> <p>Actor(s): Companies</p> <p>Description: Companies can incorporate circular demolition in their decision-making process. The market shows that public and private parties make different choices with regard to their demolition projects.</p>	2:13, 4:54, 4:55	<p>Subject: Partnerships for secondary materials</p> <p>Actor(s): Demolition companies, waste processing companies and building materials suppliers</p> <p>Description: Demolition companies and waste processors can partner with building materials suppliers to sell secondary materials.</p>	3:48, 3:49, 4:26, 4:51, 4:52, 6:58, 6:59, 6:62, 6:64, 8:44, 8:46, 8:48
<p>Subject: ROK and OVS</p> <p>Actor(s): Rijkswaterstaat and ProRail</p> <p>Description: Rijkswaterstaat and ProRail have drawn up additional guidelines for concrete, namely the ROK and the OVS respectively.</p> <p>Source: (Betonakkoord, 2018)</p>		<p>Subject: Rijkswaterstaat's interest in circular concrete</p> <p>Actor(s): Rijkswaterstaat</p> <p>Description: Rijkswaterstaat is interested in circularity in the concrete industry. On the one hand, this is interesting for the market, because they are a large consumer of concrete. On the other hand, they buy products that have to be guaranteed to have a long life, which is complicated.</p>	5:23, 5:24, 6:12, 8:53, 8:54	<p>Subject: New demolition standards</p> <p>Actor(s): Demolition companies</p> <p>Description: Demolition companies are looking for new standards for demolition. Pilot projects, such as via the SBIR, help demolition companies gain experience in circular demolition.</p>	4:40, 8:1, 8:15	<p>Subject: Market for secondary products</p> <p>Actor(s): Demolition companies</p> <p>Description: The market for secondary products is small. This creates a misalignment between parties that make potential re-use reports, who show potential waste streams that can be put on the market, and demolition companies, who can't sell the products. Another problem is that we could never meet the full product demand from just urban mining.</p>	4:7, 4:16, 8:47	

Figure 7. New matrix for institutional and regulatory arrangements, part 2. (please turn page clockwise)(Author).

National	<p>Subject: Detachability as a driver for a CE Actor(s): Fund managers and engineers Description: Detachability is seen as a driver which will boost the CE. Material funds can create a demand for detachability in the built environment.</p>	2:12, 3:23, 4:12	<p>Subject: Market readiness Actor(s): Producers of circular products Description: Sometimes the market is not ready for a particular innovation.</p>	6:6, 6:11, 6:56, 8:49		<p>Subject: Willingness to use secondary raw materials or products Actor(s): Contractors, demolition companies, waste processing companies and concrete producers Description: By certifying circular products, demolition/waste processing companies and concrete producers remove the reason from the contractor for not using the product.</p>	5:19, 6:33, 8:26	
	<p>Subject: Alternatives to concrete granulate in road foundations Actor(s): Concrete and road construction industry Description: There are emerging alternatives to concrete granulate in road foundations. An example of this is AEC (waste energy plant) granulate.</p>	3:21, 5:42, 5:43, 8:42, 8:43				<p>Subject: Categorization of secondary raw material flows Actor(s): Waste processing companies and concrete producers Description: When in some processes, raw materials are recovered from waste, these raw materials are assessed as secondary, even though they perform as well as the primary raw material.</p>	8:51, 8:52	
	<p>Subject: Compliance with Building Decree Actor(s): Demolition and construction companies Description: If a product, such as a total concrete floor, is to be reused in a new construction, it still has to comply with the building code. Difficulties come into play with regard to, for example, load per square meter, residual lifespan or re-use of materials.</p>	4:14, 5:5, 6:15, 6:21						
	<p>Subject: Alternatives to cement in concrete Actor(s): Concrete and waste processing industry Description: There are emerging alternatives to cement in concrete, like geopolymers concrete.</p>	5:4, 5:14, 8:8, 8:40, 8:41						
	<p>Subject: The concrete sector is not flexible Actor(s): Concrete producers, demolition companies, waste processing companies, legislators Description: Progressive concrete producers and waste processors believe that the cement concrete industry is not flexible.</p>	5:6, 5:10						
	<p>Subject: Collaboration in the concrete sector Actor(s): Concrete producers Description: Some concrete producers are willing to work with other producers to develop alternatives to concrete with cement.</p>	5:21						
	<p>Subject: Making new standards Actor(s): Standards committee Description: Sometimes standards are missing, for example with regard to the reuse of materials. New standards are created in a standards committee. In order to make your voice heard as a company in setting new standards, you must be represented on the committee.</p>	6:19, 6:20, 7:3, 7:4, 7:16						
Local	<p>Subject: Crisis and Recovery Act Actor(s): Municipalities Description: Municipalities can use the Crisis and Recovery Act (Crisis en herstelwet) to create room to deviate from the Building Decree, which makes experimentation possible and can promote innovation. Source: (Backes &amp; Boeve, 2018)</p>		<p>Subject: The control of the client Actor(s): Client Description: According to the Concrete Agreement (Betonakkoord), clients must be challenging in their tender regarding the minimum requirements for CO2 reduction and recycled materials. Source: (Betonakkoord, 2018)</p>	7:21, 7:23, 7:24, 7:27, 7:30, 7:45	<p>Subject: Materiaal en bouwhubs Actor(s): Gemeente Rotterdam Description: The municipality of Rotterdam wants to investigate the opportunities that a materials and construction hub can offer. These hubs facilitate storage, repair and reuse using different waste streams. Source: (Gemeente Rotterdam, 2019)</p>	7:33, 7:34, 7:35, 7:36, 8:45	<p>Subject: Digitale marktplaats Actor(s): Gemeente Rotterdam Description: Linked to the materials and construction hubs, the municipality of Rotterdam is investigating how a digital marketplace can contribute to connecting the supply and demand of secondary (construction) materials. Source: (Gemeente Rotterdam, 2019)</p>	3:5, 3:6, 3:38, 4:58, 6:61, 6:66, 8:2
	<p>Subject: 5% concrete residual flows in aggregates Actor(s): Clients Description: Clients, who have signed the Concrete Agreement, agree to have at least 5% of the total volume of aggregates replaced by concrete residual flows in all concrete. Source: (Betonakkoord, 2018)</p>	5:36, 5:37, 5:38, 7:13, 7:15, 7:17	<p>Subject: The importance of MKI/MPG in tenders Actor(s): Clients and construction companies Description: Clients and construction companies agree in the Concrete Agreement to tender concrete in such a way that the product or project MKI/MPG decreases steadily. It is also agreed that concrete that meets the MKI/MPG will be valued higher in awards. Source: (Betonakkoord, 2018)</p>	6:30, 6:32, 6:46, 6:48, 7:43, 8:24, 8:28	<p>Subject: Material passport Actor(s): Gemeente Rotterdam Description: The Municipality of Rotterdam wants to introduce a materials passport together with parties in the city. This will not only be of added value to provide insight into what is used in a building and what the MKI is, but also during the demolition or dismantling of a building. Source: (Gemeente Rotterdam, 2019)</p>	1:1, 1:13, 4:6	<p>Subject: The local character of secondary raw materials Actor(s): Demolition companies Description: The market for secondary raw materials, such as granulates, is very local, mainly because of the transport costs. Demolition companies often have local networks for the sale of secondary materials.</p>	3:16, 3:37, 3:39, 4:1, 4:47, 4:48, 4:49, 4:50, 4:53, 4:56, 4:57, 6:38, 6:40, 7:9, 7:11
	<p>Subject: Small scale experimentation Actor(s): Concrete producers, waste processing companies, legislators Description: Some parties are still experimenting on a small scale when it comes to circular concrete. Small scale innovation events, facilitated/stimulated by local governments, can be productive places to experiment with new types of concrete, like concrete without cement.</p>	5:15, 5:16, 5:22, 7:2, 7:5	<p>Subject: Permit for circular structures Actor(s): Municipality and engineering firm Description: Ultimately, a municipality must issue a permit for a circular construction. The supporting (constructive) calculations are very important to persuade the municipality.</p>	6:13, 6:14, 6:22	<p>Subject: Separation of waste streams Actor(s): Demolition companies Description: Separating the waste flows on location requires a new way of demolition, a lot of time and money. It often pays off, but the customer decides to what extent this eventually happens.</p>	3:7, 3:8, 3:9, 3:12, 3:15, 3:25, 3:26, 3:27, 3:28, 3:29, 3:30, 3:33, 3:34, 3:50, 3:51, 3:52, 4:5, 4:27, 6:36, 7:6, 8:4, 8:6, 8:9, 8:10, 8:11, 8:14, 8:16, 8:17	<p>Subject: The use of secondary materials Actor(s): Clients and demolition company Description: Secondary materials (which are local) are cheaper for the client, but sometimes requires customization to implement it.</p>	3:22, 3:31, 3:32, 8:25
					<p>Subject: Demolition for re-use is more efficient Actor(s): Demolition companies Description: Dismantling a concrete element is more expensive, but it is more efficient and it saves nuisance.</p>	4:18	<p>Subject: Storage of secondary raw materials Actor(s): Demolition company Description: Sometimes materials have to be stored so that they can be reused later. However, this costs money, which puts the feasibility under pressure.</p>	3:42, 3:43, 4:19, 6:39, 6:55, 6:65, 7:7, 7:10, 7:12
				<p>Subject: The contracts between clients and demolition companies Actor(s): Clients and demolition companies Description: Current contracts between clients and demolition companies are structured in such a way that materials become the property of the demolition company, which means that they can do whatever they want with it.</p>	6:35, 6:37, 6:41, 6:42, 6:43, 6:44, 6:45			

Figure 8. New matrix for economic activities, part 1. (please turn page clockwise)(Author).

Economic activities	Investments / Subsidies?	Quotes	Banking products	Quotes	Financial Due Diligence	Quotes	Risk evaluation	Quotes
Global	<p>Subject: 20 million dollar in seed capital Actor(s): BlackRock Description: BlackRock launched in 2019 a Circular Economy Fund worth 20 million dollars for seed capital for listed companies. BlackRock gets guidance by IMF and the eligibility of companies is determined by the UN Global Compact. Source: (Dewick et al., 2020)</p> <p>Subject: Looking beyond boundaries of individual firms Actor(s): EMF, World Business Council for Sustainable Development (WBCSD) Description: CE funds and investment decisions should use scientific tools and techniques that take into account nonfinancial aspects. Such an approach, however, is resource intensive. Because of this, EMF and WBCSD have developed circularity measurement tools for companies. Source: (Dewick et al., 2020)</p>		<p>Subject: EUR 750 million sustainable bond Actor(s): Intesa Sanpaolo Description: Intesa Sanpaolo issued a EUR750 million sustainable bond in 2019 allocated to finance businesses with a CE focus through their Plafond service. Source: (Zara &amp; Bellardini, 2021)</p>		<p>Subject: International screening criteria Actor(s): International Platform on Sustainable Finance (IPSF) Description: Technical screening criteria for the circular economy are developed by IPSF. The current classification system focuses on climate change mitigation and adaptation activities. Source: (Dewick et al., 2020)</p> <p>Subject: There is a need for international standards on what circularity is Actor(s): FinanCE Description: There is a need for global standards on the meaning of circularity, the organizational models that can be considered circular and on how circularity can be measured. FinanCE developed guidelines on this matter, which however have some limitations on the measurement of circularity, because of the used LCA method. Source: (Dewick et al., 2020)</p>		<p>Subject: Accounting rules should be adapted Actor(s): * Description: "Adapt accounting rules to enable a more representative valuation of circular business models and linear risks." Source: (Elen Macarthur Foundation, 2020)</p>	
	<p>Subject: International technology export Actor(s): Demolition company Description: Technologies in the waste sector can be exported, or the knowledge can be shared, to countries where scaling up may be possible more quickly.</p> <p>Subject: Competing with international new prices Actor(s): Demolition company Description: New prices of products that are produced internationally are so low that it is difficult to compete for demolition companies with circular products.</p>	1:20			<p>Subject: Global guidelines for CE facilitation Actor(s): International Organisation for Standardisation (ISO) Description: ISO is developing frameworks, tools and requirements for the implementation activities to facilitate CE. Source: (Dewick et al., 2020)</p>			
		3:47, 3:53, 3:55, 3:57, 6:26, 6:28, 7:41, 7:42, 7:46						
Europe	<p>Subject: ERDF Actor(s): European Commission Description: The European Regional Development Fund (ERDF) is a fund which prioritizes innovative and sustainable developments. Source: (European Commission, 2021)</p>		<p>Subject: EUR 10 billion loan and investment initiative Actor(s): European Investment Bank (EIB) in partnership with Europe's five largest national banks Description: The EIB and Europe's five largest national banks and institutions launched a loan and investment initiative of EUR 10 billion for CE activities. Source: (Zara &amp; Bellardini, 2021)</p>		<p>Subject: EU guidelines to contribute to a circular economy Actor(s): EU Expert Group on Circular Economy Financing Description: "The EU Expert Group on Circular Economy Financing is working on a classification of activities deemed to contribute to a circular economy." Source: (Dewick et al., 2020)</p>			
	<p>Subject: CO2 tax Actor(s): EU Description: The expectation is that the Netherlands will not introduce a CO2 tax on its own and that this will probably have to be done at EU level.</p>	3:68, 6:29	<p>Subject: EU Action Plan, Financing Sustainable Growth Actor(s): EU Technical Expert Group (TEG) on Sustainable Finance Description: EU's effort to reorient investments towards circular activities. Source: (Dewick et al., 2020)</p>					
	<p>Subject: Specialised machines Actor(s): Demolition companies Description: Sometimes demolition projects are carried out by international companies, because special machines are needed.</p>	4:43	<p>Subject: The need for public oversight of finance products that are marketed as "sustainable" Actor(s): European Commission, European Securities and Markets Authority (ESMA) Description: The European Commission announced to review the Nonfinancial Reporting Directive and sustainable finance strategy. Also ESMA is noticing the need for public oversight on sustainable finance products. Source: (Dewick et al., 2020)</p>					
National	<p>Subject: DEI+ Circulaire Economie Actor(s): RVO Description: The DEI+ (Demonstratie Energie- en KlimaatInnovatie): Circulaire Economie is a subsidy programme of the RVO (Rijksdienst voor Ondernemend Nederland) launched specifically for circular innovation projects. Source: (RVO, 2022)</p>		<p>Subject: "Plafond", EUR 6 billion credit facility Actor(s): Intesa Sanpaolo Description: A credit facility dedicated to businesses aligned to CE principles, with a focus on Italian SMEs. Source: (Zara &amp; Bellardini, 2021)</p>		<p>Subject: CE eligibility criteria and KPI's Actor(s): Intesa Sanpaolo Innovation Center Description: CE eligibility criteria and KPI's to support screening in the credit process for the Plafond service. Source: (Zara &amp; Bellardini, 2021)</p>		<p>Subject: Banks prefer to finance circular companies that are transforming from a linear business model. Actor(s): "Dutch banks" Description: Banks are able to obtain access to more established and secure cash flow when they are financing circular business models of companies that are transforming from a linear one, to de-risk their loans. Existing, larger firms are also more worthwhile for banks then start-ups. Source: (Toxopeus et al., 2018)</p>	
	<p>Subject: Tax benefits following Milieulijst MIA/Vamil (Environmental List MIA/Vamil) Actor(s): RVO Description: Every year, the RVO publishes the Environmental List MIA/Vamil, which indicates the amount of tax benefit for certain investments that have a positive environmental impact. It is striking that the tax benefit for concrete products containing 30% recycled material has been increased from 13.5% in 2021 to 27% in 2022. Source: (Betonakkoord, 2021)</p>	8:30, 8:31	<p>Subject: Bank lending for business model innovation (BMI) is a constraint Actor(s): "Dutch banks" Description: The lack of a track record and specificity of assets make bank lending difficult for BMI. Source: (Toxopeus et al., 2018)</p>	2:9	<p>Subject: Including future value of assets Actor(s): "Dutch banks" Description: The future value of assets is important for the bank to include in the value proposition. The contracts with customers and the specific conditions within them, such as opt-out clauses, are decisive for determining the risk on future cash flow. Source: (Toxopeus et al., 2018)</p>	1:15, 2:1, 2:7, 2:8	<p>Subject: Partnerships/collaborations in the supply chain can lower risks for banks Actor(s): "Dutch banks" Description: Partnerships/collaborations, by for example sharing ownership of underlying resources, for example through joint ventures, enables inclusion of a larger balance sheet in the risk assessment, resulting in lower risks for banks. Source: (Toxopeus et al., 2018)</p>	
	<p>Subject: Obstacles posed by the Environment Act (Omgevingswet) Actor(s): Rijksoverheid and demolition companies Description: The Environment and Planning Act sets new requirements for demolition companies, such as demolition in a "closed space" (from 2022), which requires a substantial investment to adapt the current process. As a result, less can be invested in innovative circular solutions. Source: (Betonakkoord, 2021)</p>		<p>Subject: Ownership of products Actor(s): Real estate owners Description: In the future, property owners may no longer own all of its parts or materials.</p>	2:5	<p>Subject: Training bankers to understand CE Actor(s): "Dutch banks" Description: There is a need that banks train their relationship bankers to recognize and understand circular BMI. Source: (Toxopeus et al., 2018)</p>		<p>Subject: The importance of contracts for risk assessments Actor(s): "Dutch banks" Description: The duration and opt-out clauses in client contracts affect the perceived risk of future cash flows. "Also, in the case of a buyback construction, the future value of the asset at the end of its (first) use cycle needs to be assessed and compared with the future cash outflow corresponding to the buyback price." Source: (Toxopeus et al., 2018)</p>	
	<p>Subject: Raising investments Actor(s): Demolition company, engineering company and investor Description: To invest in circular innovation, it is of great importance that its market is clear. Analyzes of the potential of reuse can help with this.</p>	1:16, 6:60, 6:63, 6:67			<p>Subject: Credit quality of the customers Actor(s): "Dutch banks" Description: Banks also aim to screen the credit quality of customers to determine whether the service or lease can be paid by the customer. The certainty that the customer can pay for the service reduces the risk of credit default for the borrower. Source: (Toxopeus et al., 2018)</p>		<p>Subject: Flexible value proposition lowers risks Actor(s): "Dutch banks" Description: In the context of circular real estate, a flexible value proposition such as a multipurpose building is of lower risk, because it can appeal to multiple types of markets. Source: (Toxopeus et al., 2018)</p>	

Figure 9. New matrix for economic activities, part 2. (please turn page clockwise)(Author).

National	<p>Subject: Demolition costs Actor(s): Clients Description: Current demolition costs are so high that the customer can invest less in new project initiatives. On the other hand, we see that circular demolition companies ensure that the benefits of demolition, such as the sale of secondary materials, can cover the costs.</p>	2:3, 2:10, 4:2, 4:3, 4:13, 4:28, 4:29, 4:30, 4:31, 4:32, 4:33, 5:32		<p>Subject: Circular Economy Finance Guidelines Actor(s): ABN AMRO, ING, Rabobank Description: The three largest banks of the Netherlands, as a part of the FinancE working group, who aim to facilitate the transition towards a CE, introduced the Circular Economy Finance Guidelines which contain prescriptions on the use of investments, impact assessment, and process evaluation. Source: (Dewick et al., 2020)</p>		<p>Subject: Risk assessment and modelling Actor(s): Central banks and financial regulators Description: "Central banks and financial regulators can integrate circular concepts in risk assessment and modeling, and could explore integrating them in less conventional methods such as green quantitative easing." Source: (Ellen MacArthur Foundation, 2020)</p>		
	<p>Subject: Material funds Actor(s): Fund managers Description: It is possible that in the near future material funds will arise in which we hold positions.</p>	2:11		<p>Subject: Innovation must be financially supported by the government Actor(s): Government and market parties Description: Market parties are prepared to invest in innovation, but they also expect the government to help with subsidies, for example. (This may have to do with the fact that these investments always carry a risk of failure)</p>	5:30	<p>Subject: Predictable volume Actor(s): Demolition company Description: Predictable volume is crucial for demolition companies. Data technologies are used to gain insight into this.</p>	1:17	
	<p>Subject: Costs in a circular economy Actor(s): Demolition and waste processing company Description: The costs of realizing circular products are very high. Products must be disassembled, researched, repaired, cleaned and stored. A large part of these costs is related to labour, with taxes in particular driving the costs high.</p>	3:44, 3:45, 3:46, 3:54, 3:56, 4:4, 4:10, 4:15, 4:17, 4:34, 4:35, 4:36, 5:8, 5:20, 5:25, 5:28, 6:54, 7:18, 7:25, 8:13, 8:20, 8:57		<p>Subject: Determining the price for circular products Actor(s): Circular product supplier Description: Determining the price of circular products is an important step. Some manufacturers believe that it should be cheaper than new prices.</p>	6:27, 6:47, 8:21, 8:22, 8:23, 8:27, 8:29	<p>Subject: Less risk results in cheaper products Actor(s): Demolition, waste processing and concrete company Description: If a client grants a demolition project to the producer (gross) before purchasing a circular product, the price of the product for the client may fall. This has to do with the fact that the demolition company does not have to look for the waste stream on the market itself.</p>	8:35	
	<p>Subject: SBIR Actor(s): RVO &amp; Rijkswaterstaat Description: The SBIR (Small Business Innovation Research) is an instrument with which the government tries to stimulate innovation for societal topics.</p>	4:9, 4:38, 4:39, 6:1, 6:51, 6:52		<p>Subject: Business model for circular construction hub Actor(s): Demolition companies Description: A common business model in the construction industry is that a subsidiary is both a supplier to the parent company and the rest of the market. This can also be expected with circular construction hubs.</p>	7:37, 7:38, 7:39, 7:40			
	<p>Subject: Circular economy and tenders Actor(s): Demolition and waste processing companies Description: The circular economy is also a means for demolition and waste processing companies to win tenders. Profit from reuse can be factored into the bid or if a party is known for its circular working method, it has a chance at an innovative project.</p>	4:42, 5:33, 5:34		<p>Subject: VAT for circular products Actor(s): Demolition companies Description: When a product is removed from demolition and sold again, VAT is levied on it. Demolition companies argue that this should disappear, because VAT has already been paid on it during construction.</p>	8:58, 8:59, 8:60, 8:61			
	<p>Subject: WBSO Actor(s): Rijksoverheid Description: WBSO is a tax scheme to reduce R&amp;D costs in order to stimulate circularity, among other things.</p>	5:26, 5:27						
	<p>Subject: New (types) of companies Actor(s): Demolition and construction companies Description: Due to the potential of circularity in the construction sector, the market currently shows that new urban mining companies are emerging or being set up by construction companies.</p>	7:8, 7:29, 7:32						
	<p>Subject: Demolition-purchase combination deal Actor(s): Demolition, waste processing and concrete company Description: In order to be able to sell circular concrete, old concrete from demolition must first be processed into new concrete. To ensure that there is a sufficient supply of concrete from demolition, a donor building is requested when purchasing circular concrete, which should also be cheaper for the customer.</p>	8:32, 8:33, 8:34, 8:36, 8:37						
Local	<p>Subject: InnovationQuarter increases access to capital for innovative companies Actor(s): InnovationQuarter Description: "InnovationQuarter is the regional economic development agency for the Province of South-Holland, also known as the greater Rotterdam - The Hague area." InnovationQuarter connects three funds (IQCapital, ENERGIQ and UNIQ) with innovative businesses, with, amongst others, a focus on circularity. Source: (InnovationQuarter, n.d.)</p>		<p>Subject: 75 million dollar in growth fund for SMEs Actor(s): Circularity Capital Description: Circularity Capital announced in 2019 a 75 million dollars growth for SMEs that outperform the market. Source: (Dewick et al., 2020)</p>		<p>Subject: Realization of value Actor(s): Demolition and engineering companies Description: Parties like demolition engineering companies try to realize the value of waste, by ensuring that raw materials can be converted into new products</p>	2:2, 5:2, 5:3, 6:49, 6:53, 7:14, 8:18	<p>Subject: De-risking effects of the CE Actor(s): Intesa Sanpaolo Description: Intesa Sanpaolo is working on new risk assessment methodologies, in partnership with Bocconi University, to evaluate the de-risking effects of the CE. This could enable more accurate assessments of benefits of circular practices, which could lead to steering of lending towards circular counterparties. Source: (Zara &amp; Bellardini, 2021)</p>	
	<p>Subject: Kansens voor West Actor(s): Provincie Noord-Holland, Zuid-Holland, Utrecht and Flevoland Description: A subsidy programme, which is largely financed by the EU via the EFRO, with the main aim to help innovation in SMEs, carbonfree economy, lowering mismatch on the market and increasing settling environments for companies. Source: (Kansen voor West II, n.d.)</p>						<p>Subject: Embeddedness of a firm within a local community of network Actor(s): "Dutch banks" Description: "[Third] evidence of embeddedness of a firm within a (local) community or network lowers the perceived risk of default. A firm that is well embedded in a community is less likely to suffer from withdrawal of funds, customers and (local government) support." Source: (Tsoopoulos et al., 2018)</p>	
	<p>Subject: Need for scale Actor(s): Demolition company Description: Scale is needed to make circular activities profitable. We are currently working on a local scale in the Netherlands.</p>	1:19, 5:31, 6:5, 6:57, 7:28, 7:31, 8:5						
	<p>Subject: Investment choices Actor(s): Demolition and engineering companies Description: With the experience that demolition companies gain during pilot projects, they can make better investments for the future, for example in machines. // Companies are willing to invest in circular solutions to put a product on the market.</p>	4:41, 5:9, 6:50, 7:19, 7:20, 7:22, 7:26						

## 5. Synthesis

### 5.1. Introduction

The new matrix, which as described in 3.7 consists of the findings from both the literature and the interviews, was used for the data synthesis. The data from the aforementioned matrix has been used in combination with the quotes in the appendixes. The synthesis consists of an extensive description of the three paradoxes of glocalization that occur in the concrete industry with regard to circular economy. These paradoxes consist of several shifts regarding institutional and regulatory arrangements and economic activities in the realization of a CE in the concrete industry. In addition, possible shifts are also included in the study that show an dependence between the different scales and sub-categories that currently form a tension. The shifts related to the paradoxes are subdivided into themes to provide structure. The quotes that can be found after each glocalization description serve as a reference to the interviews. Not all, but the most illustrative and clearest quotes have been used here.

Furthermore, the synthesis contains a visual representation of the three paradoxes, showing where in the inter-firm network the shifts and possible shifts take place. The responses of the parties in the network to the paradoxes of glocalization have also been processed using the data from the interviews.

### 5.2. Paradox of growth

*The paradox of growth describes the goal to grow in current activities, the business as usual, as well as to pursue growth in sustainable, circular activities.*

- **(1) Housing**

*National regulation* ↔ *Local enforcement*

This paradox can be seen first of all in the housing sector. There is a national demand for homes, which is also reflected in the new coalition agreement, which aims for 100,000 new homes annually, including in the affordable segments (Rijksoverheid, n.d.-b). At the same time, the ambition is to be 50% circular by 2030 and 100% by 2050. This ambition has translated into an environmental performance for buildings (MPG) that is tightened again in 2021 to force builders to build more circular and environmentally friendly (Rijksoverheid, 2021). A note that should be made with regard to the effectiveness of the MPG in the field of circularity is the fact that the circularity component still needs to be developed further. The fact that it still needs to be developed further means that the circularity aspect is less enforced. The reason for this is shown below with a quote. The consequence of not being able to sufficiently enforce circularity and the continuing demand for housing may continue to be housing projects in which circularity is insufficiently incorporated.

*D-B: Quote ID. 3:60. "Because it's actually really complicated to measure it and that's what they're still really struggling with."*

Another consequence of this paradox that is addressed in the literature is the fact that the demolition volume is many times lower than the construction task, which will lower the impact of the use of waste streams in new construction (Van Merriënboer et al., 2022).

*Local costs* ↔ *Global prices*

The paradox of growth in housing is also noticeable in the economic field. Circular construction involves a lot of costs, both in terms of R&D for the use of new materials, and in labor costs to be

able to reuse materials from demolition. This is also in line with the findings of Bani, discussed in 1.5.2, regarding the inclusion of negative externalities and high operational costs (2020).

*D-C: Quote ID. 4:15. "What we're running into is really now the costs."*

Linear products, on the other hand, are relatively cheap. This would mean that if you want to build affordable housing, you should opt for linear construction. Yet the current ambitions are to build both affordable and circular (Appendix B, Quote 3:55, D-B).

## ▪ (2) Infrastructure

The paradox of growth occurs in a similar way in the field of infrastructure. By improving and expanding infrastructure, the government is trying to make the Netherlands more accessible and to support economic growth (Rijksoverheid, n.d.-a). In addition, the national goals regarding circularity must also be pursued.

*National regulation* ↔ *Local shortages*

The infrastructure sector has been relatively sustainable in the field of concrete for many years. The foundations used under roads, for example, are largely composed of mixed concrete granulate, which comes from the demolition of concrete and other stony materials. It could be said that the waste was not dumped, but used functionally. The standards, such as the Standard RAW Determination, allow large percentages of this granulate in road foundations (Betonakkoord, 2021). In addition, the landfill ban on stony materials has greatly stimulated the supply of this granulate (Van Merriënboer et al., 2022). The fact that this material hardly needs to be processed and the large selection makes it affordable and subsequently creates a great shortage of this material in the market due to the high demand.

*Quote ID. 3:17. "Yes, you see, we are currently building so many roads throughout the Netherlands that there is actually a shortage of mixed granulate on the market"*

*Local production ambitions* ↔ *National tension on supply*

Nowadays, however, there is a more critical look at how circular concrete waste flows are handled. Some parties nowadays see the use of mixed concrete granulate as a road foundation as a low-grade reuse of materials. Another form of reusing concrete rubble is by turning it into concrete granulate. For example, the concrete agreement prescribes that at least 5% of new concrete must consist of concrete granulate (Betonakkoord, 2018). This is seen as a higher degree of circularity, because concrete ends up in concrete again. Because there is a desire to grow in both the concrete market and the infrastructure market, and circular growth is a given, there is a great deal of tension about how the concrete rubble will be processed and where it will end up.

*Quote ID. 5:41. "In fact, there is a little too little concrete rubble granulate in that regard to fully supply the market."*

- **(3) Waste sector**

The paradox of growth also emerges in the waste sector. Demolition and waste processing companies are both commercially driven companies, which among other things aim to expand their activities. At the same time, there is an aim with regard to circularity, to aim for the highest possible R on the R-ladder (Refuse, Reduce, Reuse, Repair, Recycle, Recover) (Hanemaaijer, 2021). This goal is not only communicated from the government, but is sometimes also part of the business mentality of the demolition and waste processing company. The paradox of growth occurs when both the business activities are desired to be expanded and the degree of circularity, because of reasons described below.

*Local production ambitions* ↔ *Local costs and profit motive*

When a demolition company wants to increase the degree of circularity in demolition, the client, who puts the demolition project on the market, must also be on the same page with regard to the work. Circular demolition can cost more time and money. If the client has no circular ambitions, it will be difficult for the demolition company to do circular demolition, which within this ambition would mean that the demolition company would have to look for another project. However, this would not be in line with the company's commercial goals, in which the aim is to win tenders and generate turnover. The following quote illustrates that some clients aren't as enthusiastic about the costs and benefits of circularity as the circular demolition company.

*Quote ID. 3:51. "[...] And of course people sometimes say, yes, but [D-3], that takes a lot of time and a lot of extra work. What are you doing difficult?."*

Something similar is happening at the waste processing company. When processing concrete rubble into mixed granulate or concrete granulate, the waste processing company depends on the quality of rubble delivered by the demolition company. By setting requirements for quality, or by adjusting the price per quality, a waste processor can influence the inflow (Van Merriënboer et al., 2022), but rules that are too strict can cause them to lose clients.

### 5.3. Paradox of co-opetition

*The paradox of co-opetition describes the situation in which parties both want or need to cooperate while also having to compete.*

- **(1) The use of waste streams**

With regard to the use of waste streams, the paradox of co-opetition is recognizable in the case that demolition companies and waste processing companies have to work together to make optimal use of the waste streams, but that demolition companies also have to try to take more advantage from waste streams, in order to remain competitive with other demolition companies.

*Local partnerships* ↔ *National activity*

In a circular economy, one of the goals is to be able to reuse waste flows in a high-quality manner. In the current market it can be seen that several parties are involved in succession in the production of new products from buildings that are being demolished, as shown in the inter-firm network analyses. The consequence of this is that the working methods of the companies must be aligned with each other. For the construction sector, for example, this starts with the dismantling of the buildings. How the dismantling takes place determines the quality of the resulting waste flows (Appendix A, Quote 4:27, D-C). For example, if a waste processing company wants to reuse the incoming concrete flows in a high-quality manner, but requires a certain degree of quality for this and wants to set

requirements for the incoming waste flows, agreements must be made with the demolition companies. Long-term agreements or partnerships can be made to ensure that this process runs as smoothly as possible.

*Quote ID. 8:9. "those raw materials must of course be very pure in order to be able to make reliable products again at the back. [...]"*

Although partnerships can be interesting, it is not easy for all companies to achieve this. Demolition companies that are nationally active and therefore carry out demolition projects in all parts of the country, are often looking for local parties who can process the waste flows. This has partly to do with the transport costs of the waste streams. This means that although demolition companies sometimes strive for long-term relationships with waste processing companies, for example because they want to choose a more sustainable party, they cannot always achieve this due to the preconditions of the demolition project concerning budget and emissions.

*Quote ID. 4:56. "But I must say that this is also region-specific." & Quote ID. 4:57. "You also have to deal with footprint and things like that with certain tenders. So that you have to look at what those CO2 emissions are, so [then] of course [we] try to sell as much as possible locally."*

*Global prices* ↔ *Local networks*

With regard to transport costs and the location-relatedness of the activities, the relationship with glocalization is very present. Fuel prices in the Netherlands are largely dependent on the international oil market. When fuel prices rise, transport becomes more expensive, making the networks between demolition companies and waste processors increasingly local.

*National collaboration* ↔ *Locally emerging companies*

The interest group of the construction sector also emphasizes that collaborations are becoming increasingly important. The emergence of new types of demolition companies, what are called urban miners, new waste processing companies and marketplaces for circular materials may have the effect of negating the efficiency gains made in recent years in the construction sector. It is stated that parties should cooperate more and that, for example, not all construction companies should set up their own urban mining subsidiaries.

*Quote ID. 7:36. "What I don't see is that every company should build its own depot and set up its own men and have to grind that concrete yourself, because that just doesn't make sense."*

*National financial support* ↔ *Local competitiveness*

Circular products put on the market can sometimes have a higher price than linear products. Programs with tax benefits have been set up to cover this price difference and to stimulate the market for circular products (Betonakkoord, 2021). Some parties are also willing to accept higher prices for circular concrete, because this allows them to reduce their CO2 footprint, without making adjustments to traditional construction methods. The ability to charge more for circular concrete is a competitive advantage that not all companies will want to share.

*Quote ID. 8:23. "For cement you can have the discussion whether I shouldn't get more for it. Because we are gradually also pricing CO2 emissions in construction." & Quote ID. 8:27. "And so you may even be able to charge a little more for it."*

*Local competition* ↔ *Local collaboration*

When demolishing a building, a demolition company tries to calculate which products can be removed from the building and then sold. The more they succeed in removing products from the building and selling them, the lower they can make their bid during the tender for a demolition assignment, because they can still make a profit from selling the waste. At the same time, the waste stream that comes from demolition is also a feed stream for waste processing companies, which then earn money from it. Although it has been illustrated above that it is important that demolition companies and waste processing companies work together, it can be seen here that the competition that takes place between demolition companies can put pressure on this need for cooperation.

*Quote ID. 4:42. "Well, you can submit a tender more competitively. [...]"*

▪ **(2) Marketplaces**

With regard to marketplaces, the paradox of co-opetition also emerges. To be able to realize enough supply, parties in the circular concrete industry have to work together and at the same time, parties want to maintain their network as a competitive advantage to be able to sell circular materials.

*National scale of the market* ↔ *National collaboration*

One of the difficult things about CE is being able to sell circular products. Because the market is now in a phase where they want to scale the business, it means they have to reach more and more customers (Appendix B, Quote 6:5, E-A). In this respect, some parties are waiting more for the demand market. They see the inability to sell the materials as a result of the lack of demand for these products. There are also parties that are trying to find a solution for this by setting up marketplaces. An online marketplace can be a tool to make the match between customer and seller. Some parties believe that these marketplaces should be shared platforms where multiple companies work together to market their products.

*Quote ID. 6:66. "We will also have to set up marketplaces. So a marketplace for second-hand bridges. Can we link a beam bank to it? That market parties can also make that match. So we put there on that beam bank, these become available, who wants them? So that the rest of the Netherlands can also register."*

*Local sales inefficiency* ↔ *Local competitiveness*

Demolition companies that have a head start on the market with regard to circular products have a lower incentive to collaborate with other market parties. However, it can also be seen that companies in the demolition sector need collaborations, because many different types of waste streams come from a building, making it difficult to market large quantities efficiently. As discussed briefly above, being able to sell waste streams is a competitive advantage for demolition companies, because they can make a sharper offer during tenders. For some companies, the contact with their local network, which has been built up over the years, is very important in order to estimate in advance at what prices they can sell products, so that they can accurately make an offer for a demolition tender. In order to reach more customers, a shared marketplace could be chosen, but this could have the effect of weakening ties with the network of buyers, which is crucial for some demolition companies to remain competitive.

*Quote ID. 4:42. "[...] The stronger the network actually is, so the more customers you have with recycled materials, the more competitive you can submit a tender."*

#### 5.4. Paradox of long-term/short-term

*The long-term/short-term paradox describes the need to both facilitate long-term actions and take short-term actions.*

##### ▪ (1) Regulation and standards

The long-term/short-term paradox is visible when it comes to regulations and standards, because this must take into account the stimulation of the current market and the maintenance of reliable production, as well as steered towards long-term good market functioning and ambitious high impact measures.

*National demand circular products* ↔ *Local waste management*

Current regulations are an essential part of the business case for some parties active in CE. This is the case, for example, with regard to the MPG. The MPG is set up assess projects based on sustainability. When ambitious MPG requirements are included in tenders, designs that are more sustainable will have a greater chance of being realized. This initiative aims to increase the demand side for sustainable products. This can be seen as a short-term incentive. The next two quotes illustrate the consequences of this.

*Quote ID. 8:24. “[...] You have to set a maximum on the environmental performance of your building, the MPG value, and that maximum will be adjusted downwards by the government. [...]” & Quote ID. 8:28. “If you didn’t have this [circular] concrete, and the standards says that the MPG will be reduced by 20% in 3 years, if you have to get that 20% saving from building materials other than concrete, then you have to make huge investments. [...] Concrete is perhaps the easiest, along with brick, to achieve that saving. And thus it represents value.”*

In addition, it is also necessary to adopt a long-term perspective in order to stimulate total market forces. In addition to a high demand, it is also necessary to create sufficient supply. The offer for circular products is created from the demolition of a building. However, current regulations and contract models do not include the incentive to use circular demolition instead of traditional demolition. Because there are sometimes long-term contracts with regard to demolition, it is necessary to adopt a long-term perspective in this area.

*Quote ID. 6:43. “And my colleagues are also working on new contracts where you notice that you have to sit a few years before and then you have to think about 5 years. You have to start about that now, with a project that will only be on the market in 5 years.”*

*National production regulation* ↔ *Local production ambitions*

The paradox of long-term/short-term is also recognizable with regard to standards in the concrete sector. In recent years, the standards for secondary material in concrete have been modified to allow a higher concentration in new concrete production (Betonakkoord, 2021). These percentages of secondary material must be set in such a way that no risks can arise with regard to the use of the concrete. This is done on the basis of currently available knowledge. Some parties are satisfied with the level of ambition of the current standards and believe it is correct that the level of secondary material is gradually increasing in order to give the market the opportunity to gain experience with this new type of concrete and to better understand the long-term safety of the concrete.

*Quote ID. 4:24. “but of course they also want to hold back a bit, because if something happens in 10 years’ time to a building that contains more than 20% gravel replacement, that is of course a bit of a disincentive, yes, we’re not going to put too much into it.”*

There are also parties who believe that the current standards are too low, because there is knowledge that more secondary material can be processed in concrete. They believe that a long-term perspective is important when setting standards, because it is a missed opportunity to save on impact in the form of CO2 if we do not focus enough on more ambitious standards for secondary materials in concrete. The current cement and concrete industry is accused of being conservative (Appendix A, Quote 5:10, WP-B).

*Quote ID. 5:36. "They have set the ambition to replace 5% of the primary material with concrete granulate or secondary materials." & Quote ID. 5:37. "Well, I can already tell you, we use 50%."*

## ▪ (2) Investments

The long-term/short-term paradox plays a major role in making investment choices, because there is both a demand for investments in the current task towards circular transformation and a demand for long-term investments where it is crucial to understand which direction the market is heading.

*Local investments*  *National subsidies*

Establishing a CE in the concrete industry requires investments in various areas. In the short term, for example, demolition companies have to transform their linear way of working into a new circular way of demolition. This means, for example, that they have to find another way to remove products or material flows from a building with less damage and in a cleaner way. This new way of working is not only a learning process, but also requires investments to realize this affordably.

*Quote ID. 3:30. "Yes this costs extra, but you are indeed [working] in a different way, you are indeed sawing things loose, instead of squeezing and at the same time [it] also yields a lot."*

Waste processing companies and concrete producers also require short-term investments in order to be able to innovate. This concerns, for example, being able to use more secondary materials in concrete or even being able to produce concrete without cement, which can have a major impact on the CO2 footprint of concrete. The demand for this innovation comes from the government, however. This ensures that companies expect subsidies for these innovations to be drawn up from the government. This can be done in several ways. You can choose to subsidize the innovation process (RVO, 2022) or the innovative product (Betonakkoord, 2021), making it affordable or beneficial in the short term.

*Quote ID. 5:30. "If the government wants something and you don't subsidize anything, then people drop out anyway, because yes, people do want to invest, but yes, a certain part must of course be financed."*

Investments are also needed that must be made from a long-term perspective. For example, demolition companies use machines that they depreciate over the long term. A good understanding of what is required for the work in the long term can be beneficial when making investment choices. Subsidized pilot projects can help companies gain experience with CE so that they can make better long-term choices.

*Quote ID. 4:41. "What kind of machines do you need for that? What should we invest in in the future? Are we going to invest in hammer or are we going to invest in some kind of brush that can sand off the top layer?"*

*Local investments* ↔ *National (future) market*

Also, taking into account the long-term perspective can have a negative effect on investments in the CE. For example, an engineering firm has stated that companies will not invest in the CE if they do not know what the market will look like in the future and whether they will earn back the investments. This has to do with the fact that companies also have to make a margin, so also weigh the risks associated with investing in the future.

*Quote ID. 6:67. "We are excited to put energy into this. But we won't invest a lot of money if we don't know whether it will pay off in the end."*

*Global material prices* ↔ *National CE feasibility*

With regard to investments and the long-term/short-term paradox, globalization, and in particular the dynamics between global and national, plays a major role. When the prices of commodities that are traded internationally rise, the business case for re-use of materials changes. When the price for a new product becomes higher than the price of a re-used product, there can be more demand for it, which can make investing in re-use more attractive. This is currently going on with regard to rising steel prices due to the war in Ukraine and the demand for steel for re-use.

*Quote ID. 7:46. "It also helps, the whole price increase due to the war in Ukraine. You can see that for steel, for example, it is already much more attractive to reuse it from existing buildings than to have new steel pressed. Just because it just got really expensive."*

This dynamic also plays a major role in the long-term perspective. If there is good insight into the trends of internationally traded materials and the costs nationally for re-use, better long-term investments can be made. Current expectations regarding concrete are that although investments for circular concrete are now debatable, investing in circular concrete will pay off in the long term.

*Quote ID. 7:42. "and it will be cheaper in the long run."*

## 5.5. Paradox diagrams

The paradoxes described in 4.2 to 4.4 are summarized below in three figures. These figures are abstract representations of the inter-firm networks and are intended to indicate where in the network the paradoxes of glocalization occur and to summarize in 4.6 how the inter-firm networks deal with these paradoxes.

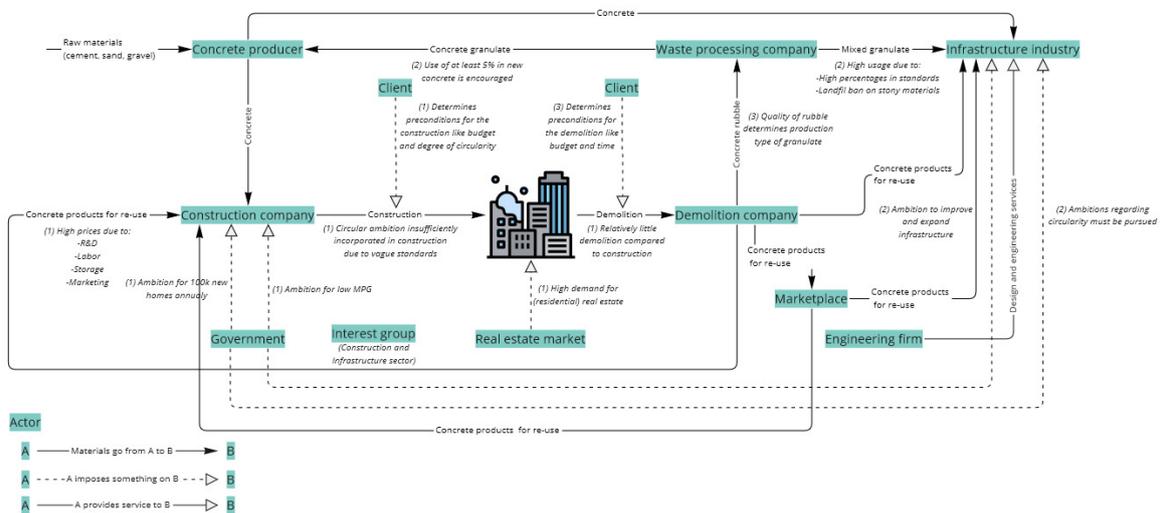


Figure 10. Paradox of growth shown in the inter-firm networks figure (Author).

The paradox of growth is shown above in the inter-firm networks figure. The numbering of the themes described in 4.2, i.e. housing as 1, infrastructure as 2 and waste sector as 3, can also be found in the figure. It can be seen that the glocalization aspects described in 4.2 play a role across almost the entire network. In particular, the role of the government and the clients is striking. Although they do not play an active role in the material flow, they do have a major influence on it.

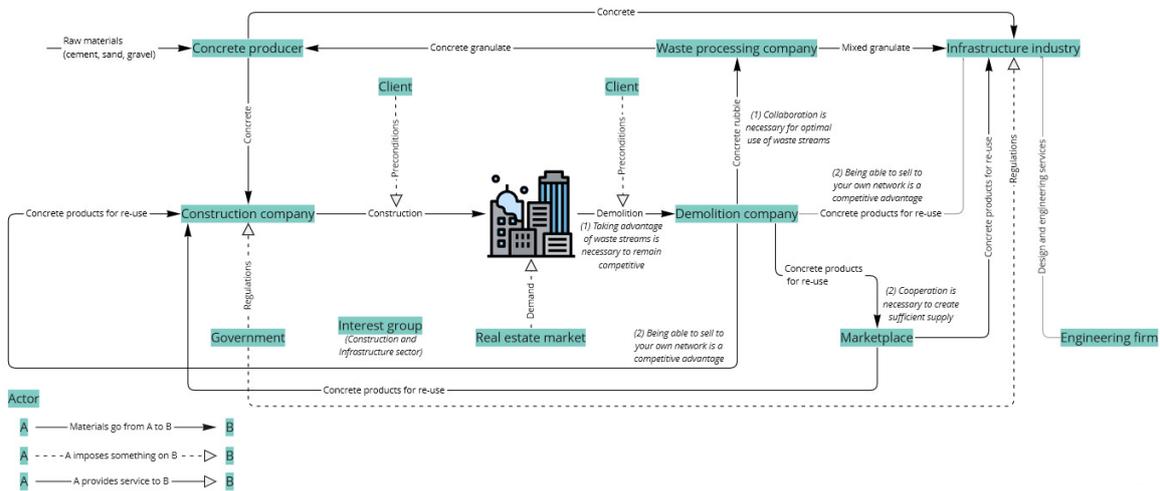


Figure 11. Paradox of co-opetition shown in the inter-firm networks figure (Author).

The paradox of co-opetition is shown above in the inter-firm networks figure. Here too, the numbering of the themes has been added, which are described in 4.3, so 1, use of waste streams, and 2, marketplaces. It is striking that this paradox appears to be completely related to the flows to

and from the demolition companies. However, this makes it interesting to see what the influences are of the other types of actors with regard to this paradox in 4.6.

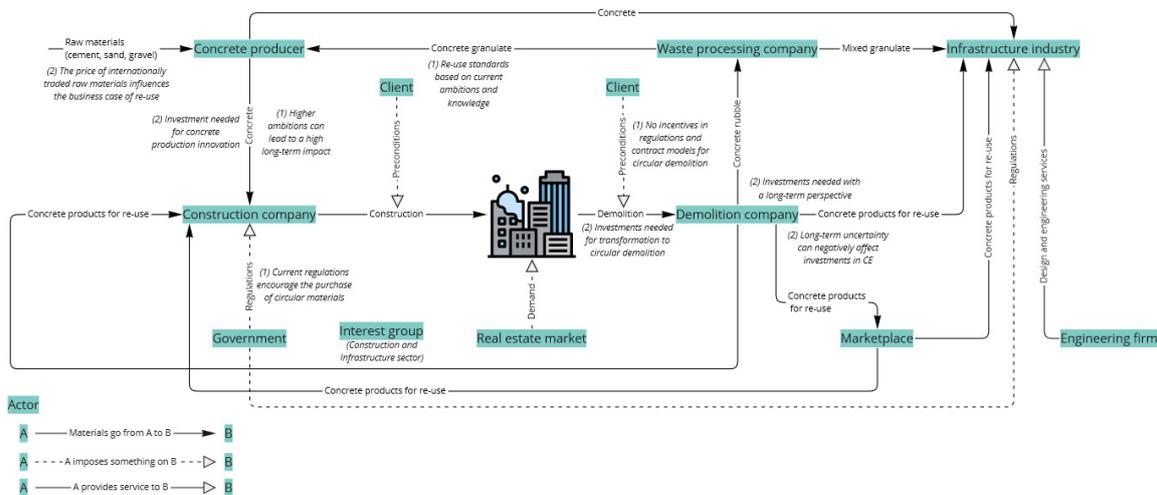


Figure 12. Paradox of long-term/short-term shown in the inter-firm networks figure (Author).

Above, the paradox of long-term/short-term is shown in the inter-firm networks figure. The numbering corresponds to the themes in 4.4, i.e. 1, regulation and standards and 2, investments. Similar to the paradox of growth, it can also be seen that a large part of the network has to do with the paradox.

### 5.6. Actions of inter-firm networks on paradoxes

This section is a synthesis of the interview results, paradox descriptions and paradox diagrams. The figures below show how the interviewed companies deal with the paradoxes of globalisation. Because the interview results have also been used to describe the paradoxes, some of the responses in the figure will correspond to what is described in 5.2 to 5.4. All responses are based on quotes from the interviews, which can be found in Appendix A and Appendix B. The actions of the companies and organizations are grouped into 3 types of actions: proactive, acting in such a way as to address both aspects of the paradox, reactive, in which only one aspect of the paradox is addressed, and inert, in which no action is taken on the paradox.

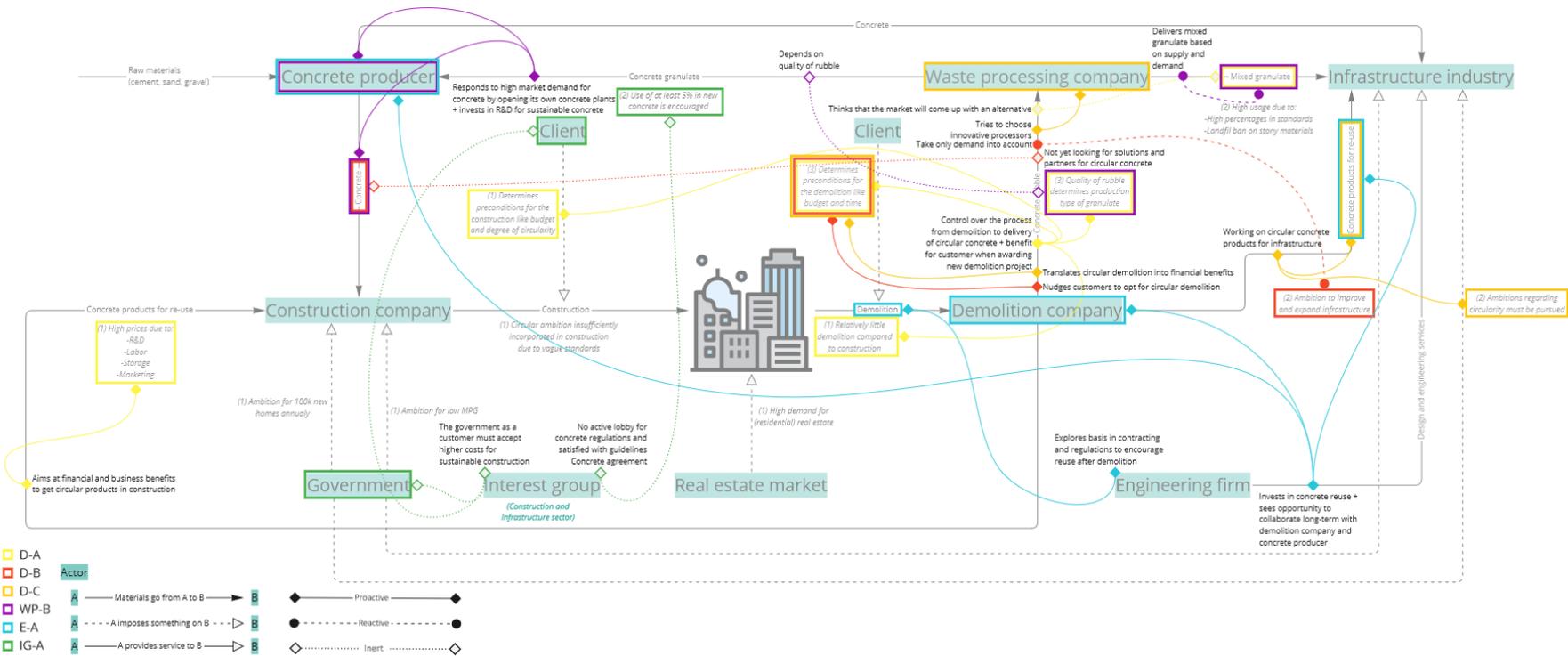


Figure 13. Paradox of growth with the actions of the interviewed companies and organizations (please turn page clockwise) (Author).

The figure on the previous page shows the actions of the interviewed companies and organizations on the paradox of growth. To maintain an overview, the actions are discussed per type of actor.

First, it is noticeable that all the demolition companies take a proactive stance towards the influence that the client has on the demolition process. In particular, a way is being sought to reduce the financial burden of circular demolition, to make it more feasible. It can also be seen that the waste sector, i.e. the demolition companies, except for D-C, and the waste processing company are reactive or inert with regard to the paradox of growth in the infrastructure sector. In particular, they only respond to the demand for granulate for foundations, which can be seen as a feasibility-driven action. Demolition company D-C and engineering firm E-A are, however, looking for innovation in the infrastructure sector together. In total, this could mean that business as usual in this sector will continue, but that certain advances in innovation could still change that.

In addition to looking for innovation in the infrastructure sector, the engineering firm E-A is also concerned with the influence of the client on the demolition process. In contrast to demolition companies, this proactive attitude is sought in the contractual side of the problem, where a way is sought in new contracts to integrate reuse after demolition.

At waste processing company WP-B, the figure shows that following the demand for circular concrete, a proactive attitude is adopted and the business activities are broadened from waste processing to also concrete production. This shows that a business model action has been initiated, which can subsequently also have an impact on the total inter-firm networks.

Finally, it can be seen that the interest group is inert to the paradox, but it is striking that they are one of the few that focuses precisely on the influence of the government on the paradox of growth, arguing that governments should tender more sustainably regardless of the high cost.

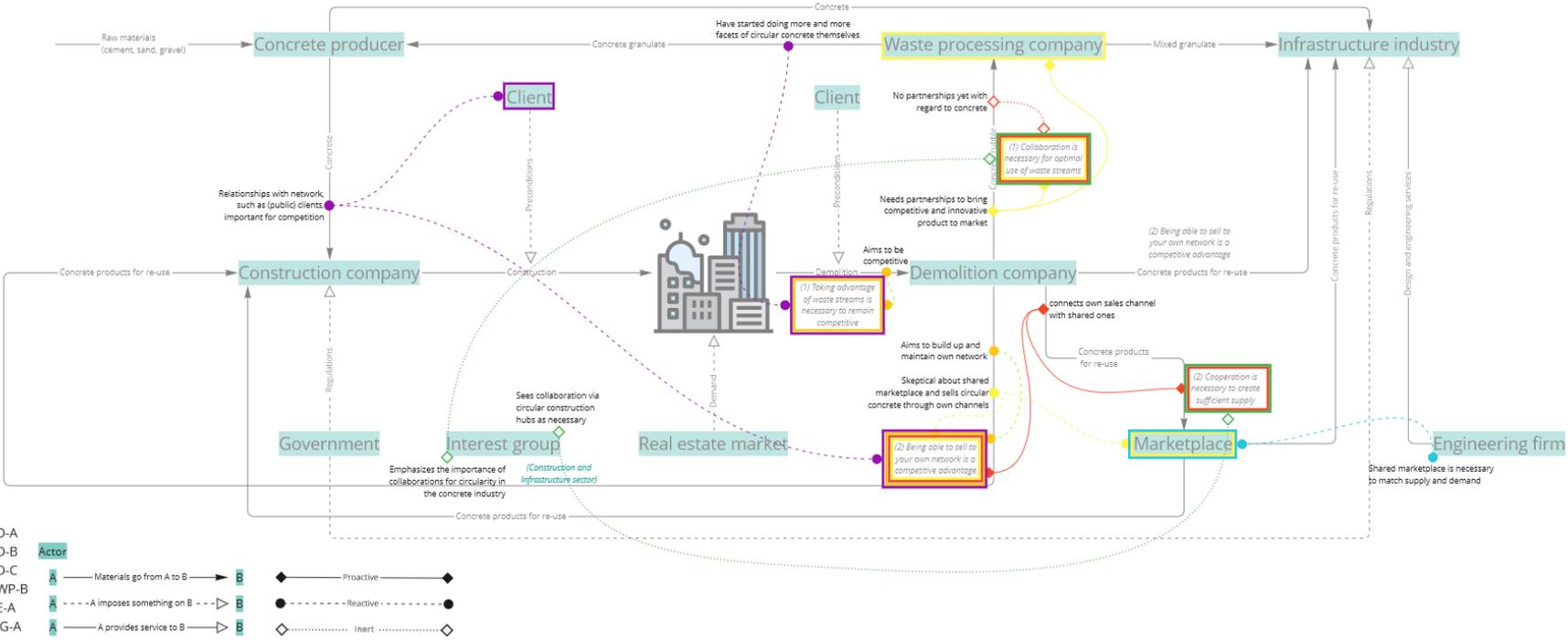


Figure 14. Paradox of co-opetition with the actions of the interviewed companies and organizations (please turn page clockwise) (Author).

As in the previous section, it will also be discussed here per type of actor how people respond to the paradox of co-opetition, which can be seen in the figure on the previous page.

The figure shows that the demolition companies that were examined behave differently towards the paradox. For example, it can be seen that D-C is more competitive and has a reactive attitude to the paradox, whereby they want to build a network of companies themselves where they can sell the products from the demolition. This is primarily a feasibility-driven decision. The demolition companies D-A and D-B have a proactive and collaborative attitude, which may also have implications for the inter-firm network. For example, D-A sees it necessary to work together with waste processing companies to bring innovative products to the market. At D-B, the motivation is to work together to reach a larger market through a shared marketplace.

The idea for a shared marketplace where different demolition companies can offer their products and construction companies can buy is also supported by the engineering firm E-A and interest firm IG-A. This idea is mainly a business model action, because parties have to consider whether they want to enter such an open marketplace, which can affect, for example, their competition and sales partners.

Finally, it can be seen that the waste processing company WP-B has a reactive attitude to the paradox, focusing in particular on maintaining relationships with (public) clients, which can be seen as a feasibility-driven decision.



How the different actors respond to the long-term/short-term paradox, which can be seen on the previous page, is discussed in the paragraphs below.

Attitudes to this paradox are again divided, like the previous ones. Demolition company D-A, for example, has a proactive attitude towards higher ambitions for circularity in concrete production. They do this by lobbying, using their innovation as an example for more progressive regulations. The same kind of attitude is also adopted by waste processing company WP-B. The other demolition companies, D-B and D-C, on the other hand, are inert to the paradox and show only legal compliance. This latter attitude is also shown by interest group IG-B, which is satisfied with the current ambitions.

When we look at how the waste sector, ie demolition companies and waste processing companies, respond to the long-term/short-term paradox regarding investments, it can be seen that they all take proactive stances and make short-term investments to benefit in the long term. This choice is mainly driven by the need for innovation.

Engineering firm E-A also reacts proactively to this paradox, but with a different approach. They are trying to investigate the potential of the market in order to gain a better understanding of the possibilities for investing in CE. In this case, E-A's specific ambition is to start a joint venture for the supply of circular concrete products together with, among others, a demolition company and a concrete producer (Appendix A, Quotes 6:58 up to and including 6:63, E-A). This attitude is therefore more driven from a business model approach.

## 6. Discussion

### 6.1. Introduction

As described in the introduction, the transformation to a CE is important to address current environmental and geopolitical problems. Governments are important actors in this regard, because they must conduct a facilitating and stimulating policy and, also as a market party, must set a good example. Both the Amsterdam example in 1.2, in which several means are mentioned to stimulate CE, such as new policy, knowledge sharing and financial support, and the goals that the municipality of Rotterdam has to investigate circular construction hubs, material passports and digital marketplaces, mentioned in 2.5, show that governments are taking the transition to a CE seriously. The importance of governments is also recognized by the actors who have been interviewed. However, this research shows that the paradoxes of glocalization are not sufficiently taken into account in policy making, leading to imbalances in the inter-firm networks. An example of such an imbalance is given with regard to the demand that the MKI regulation provides for circular products, while the supply of such products lags behind because there is not enough incentive.

In this thesis a lot of research has been done on the waste sector. Demolition companies and waste processing companies are driven to make steps towards a CE with regard to concrete, despite the fact that the motivations can differ per actor. It has been found that for some it is an intrinsic motivation to achieve environmental objectives, while for others the CE is seen as a way to gain economic advantage. Regardless of the motivation, what the waste sector is taking can be seen as a positive step. However, the research shows that the market is ahead of policy in several aspects, which on their part raises the demand for governments to take action. What goes wrong here, however, is that the market parties currently do not use a clear strategy and that there is no coordination. This can be seen in the differences in actions that are taken, as described in 5.6, such as feasibility driven actions, innovation, business model adjustments and legal actions. This makes it difficult to implement policies or take economic actions that include the entire inter-firm network.

It is also interesting to see that during the interviews the European and global scale are rarely mentioned by the market parties. In accordance with the information in the literature, this is probably because the Netherlands and the Dutch market parties have higher circular ambitions and are ahead in circular knowledge than the EU and beyond. However, the problem with supra-national CE aspects lagging behind is that the linear market can still continue to grow internationally and maintain an influential position on a national scale, for example having an effect according to some of the interviewees on the development of the law and regulations in the concrete industry. Therefore, the inert attitude of the interest group(s) has to change, in order to lobby the interests for the transformation to a CE in the concrete industry at international companies and interest groups.

Finally, consideration should be given to how clients with a construction demand should look for solutions together with contractors to incorporate circularity in future construction assignments. The need for this is partly caused by expected regulations, but also geopolitical factors, such as price fluctuations and supply risks. The interview data shows that the high costs play a role in insufficient processing of circularity, which can, however, be tackled by, for example, providing insight into data relating to construction and demolition assignments, so that supply and demand can be matched. This insight was to be expected based on the literature, the municipality of Rotterdam is working towards such material passports (Gemeente Rotterdam, 2019). However, this research shows that several aspects play a role in matching supply and demand with regard to concrete, such as the location dependence of the waste flows, the demand for the product in other markets and the

technical and process feasibility of the reuse. The complexity of this problem demonstrates the need for an approach that considers the entire inter-firm network.

## 6.2. Academic implications

This research has implications for policy makers, practitioners and the academic community. For policy makers, the results indicate that it is necessary to take a holistic approach to CE policy making in the built environment, looking at how inter-firm deal with the paradox of glocalization. In the long-term/short-term paradox, for example, it can be seen that pursuing a policy to increase the demand for circular products, but the lack of policy in the field of incentives for the supply of circular products can lead to an imbalance in the long term. For practitioners, this research is relevant because it can create awareness about how other companies in the network deal with glocalization. Understanding the shifts taking place with regard to institutional and regulatory arrangements and economic activities can help to understand the implications for their own inter-firm networks. For the academic community, this research is first of all an addition to research on inter-firm networks in a CE, which was still quite limited. In addition, the study illustrates the importance of the concept of glocalization and the paradoxes it poses in analyzing how the CE can be achieved, by showing that the inter-firm networks take different actions under the same conditions that constitute the paradoxes. This is a starting point for further research, because this research only examined 'how' the inter-firm networks deal with the paradoxes, but not 'why'. The recommendations are discussed in more detail in 6.4.

## 6.3. Limitations

This research also has some limitations. Starting with the literature review, it can be seen that the explorative nature of the literature review makes it difficult to know when sufficient information has been collected from the literature. The many additions that were eventually made to the matrices as a result of the interviews raise questions as to whether all this information is missing in the literature, or whether insufficient literature has been explored. As mentioned in 4.3, this is particularly the case for economic activities, where there is little connection with explored literature, and many new additions have been made to the matrix as a result of the interviews. This could be investigated by taking the new matrix with the additions from the interviews as a basis for conducting a literature search in the future. If it is not due to the explorative nature of the literature study, it may be due to the level of abstraction at which the CE research is conducted in the construction sector and in the concrete industry.

The research uses the theoretical framework of glocalization as a basis to look at CE in the construction sector from this perspective. Because this framework is relatively abstract, the interview questions have been simplified and nudging questions have been used during the interviews to find out more on some points, for example with regard to the scale levels of activities. However, the need to simplify the questions has at times in some interviews led to an oversimplified answer.

The data used from online public interviews also has peculiar limitations. First, there is a dependence on the questioning by the interviewer. There is a dependency on the interviewer not only with regard to the question, but also with regard to follow-up questions and nudge questions. Also, sometimes the length of the interview can lead to short answers that don't go deep enough. In addition, the audience or the occasion of the interview can play a role in how questions are answered. Also, the public nature of the interview may lead to some information being withheld. The findings from the online interviews were verified verbally and informally during meetings with the relevant parties. Despite the fact that more information emerged during those conversations, this was not included in the study for reasons of verifiability.

During the coding of the data, the additions “opportunity” and “problem” were used in accordance with the desired information regarding sub-questions 3 and 4. In retrospect, a third sentiment could also be added that is "neutral", as some coded quotes are more of an observation than an attribution of an opportunity or problem. This would make the reference work more accurate.

When making the data synthesis, it is also difficult to make comprehensive findings within this research. Several different companies were contacted to collect relevant data from different perspectives within the inter-firm network of the concrete industry, but within the time constraints and following the interests of the parties, a selection of interviewees emerged. In this selection, for example, some important actors such as a construction company and the client are missing. With regard to the selection criteria set for the interviewees in 3.1, it appeared that the last criterion: *"Interviewee is familiar with the problems the company faces and the opportunities the company recognizes in relation to the CE."* turns out to be insufficient, due to the lack of depth in the answers experienced during some interviews. In the future, this could either be described in more detail to make expectations clearer, or an informal conversation could be held beforehand, in which the knowledge of the interviewee can be estimated.

Sub-question 3 of this research, which reads: "What are the opportunities and problems of glocalization in realizing a circular economy in the construction sector?", appears to be difficult to answer, due to the complex balances regarding the paradoxes of glocalization described in the synthesis. The research illustrates that glocalization can be an opportunity for one actor and at the same time a problem for another in the same inter-firm network. As a result, it is not possible to give one unambiguous answer to this question in its current form. Therefore, in the conclusion, chapter 7, reference is made to the interview results and findings from the literature.

As described in the methodology, an abductive method of inquiry was used in this research. Phases have been established for the research, as can be seen in figure 3, in which different steps follow each other. However, in the research of Dubois and Gadde (2002) it is argued that such a method with phases insufficiently exploits the potential of abductive case studies. A methodology is advocated that adopts an integrated approach, continuously switching between the different research activities in order to gain a better understand for both empirical and theoretical phenomena. An abstract representation of this methodology can be seen in the figure below. Despite the fact that this methodology could provide interesting findings within this research, it is doubtful whether this would be a correct approach within the (time) constraints of this thesis.

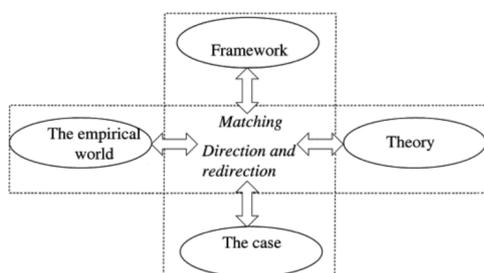


Figure 16. Systematic combining (Dubois & Gadde, 2002)

#### 6.4. Recommendations

As mentioned in 6.3, there were limitations during this research, among other things with regard to the lack of a number of actors that can offer an interesting perspective on CE in the concrete industry. In a follow-up study, data can be collected from actors such as the construction and demolition client, construction companies and governments. As has often been shown, the

perspective of the client, both during construction and during demolition, is still an important factor at the moment, because the client is largely decisive where the law and regulations do not rule. With regard to construction companies, although data has been collected from the interest group of construction and infrastructure, direct data from construction companies can also provide more nuances with regard to the topics discussed during the interviews. Finally, the perspective of local, regional and national governments can provide interesting findings, as they not only influence institutional and regulatory arrangements, but also play a major role in economic activities as clients in construction and demolition. In particular, the exemplary role that governments hold can provide interesting insights. The perspective of Rijkswaterstaat may also be interesting, because of their major role in the infrastructure sector and influence on concrete regulations.

With regard to the data synthesis, the visual part, i.e. the mapping of the paradoxes, is a point of attention for further research. This method in its current form is insufficiently visually scalable. It is therefore possible to look for another method that can provide more overview. It would be particularly interesting to explore a method that clearly depicts not only the actions of, but also the implications for the inter-firm networks.

The synthesis shows that many of the interviewees' considerations are based on quantitative aspects, such as current and expected prices for labor and materials, supply and demand for material flows and investment costs for process adjustments and price leveling. It may be interesting for future research to include this quantitative aspect, for example to see which actions are taken at which price levels or other quantitative factors.

Follow-up research can also look into the possible correlation between the phase in which a company is in the industry life cycle and how the paradoxes of glocalization are dealt with. The industry life cycle indicates 4 phases, namely: expansion, peak, contraction and trough (Chan, 2021). As an example, looking at the actions of D-A and D-C in the paradox of co-opetition seen in 5.6, there is a difference in attitude. D-A is proactive and seeks partnerships to innovate, where D-C tries to maintain and expand its current network and can be categorized as reactive. D-A is relatively young and in the context of the industry life cycle can be seen as being in the expansion phase, while D-C has been around for a lot longer and is now either in the peak, or in one of the phases after it. By looking at the data in this way, interesting correlations could potentially be found. However, with the amount of data from this study, it would be unreliable to make a statement about any correlations.

## 7. Conclusion

The main question of this research was: *“How do inter-firm networks deal with the paradox of glocalization in realizing a circular economy in the construction sector?”* This question was answered on the basis of 5 sub-questions. The conclusions of these sub-questions are first discussed below.

### 1. *What is glocalization and how does glocalization relate to the circular economy?*

The definition adopted for glocalization in this study is: *“‘Glocalisation’ refers to the twin process whereby, firstly, institutional/regulatory arrangements shift from the national scale both upwards to supra-national or global scales and downwards to the scale of the individual body or to local, urban or regional configurations and, secondly, economic activities and inter-firm networks are becoming simultaneously more localised/regionalised and transnational (Swyngedouw, 2004).”* Within this concept, the categories of institutional and regulatory arrangements and economic activities are subdivided into four sub-categories each, that are relevant for a CE in the construction sector, based on literature research. On the basis of a literature search, relevant topics with regard to the sub-categories and scale levels were subsequently summarized in figures 1 and 2. Although this summary does not directly mention shifts as they are described in the definition of glocalization, it does show on what subjects these shifts can occur.

### 2. *What are inter-firm networks in the circular economy?*

As described in 2.6 no direct definition is given in the literature for inter-firm networks, but how they appear. Based on this, an analysis was made in 2.6 of what this looks like in the CE in the concrete industry on the basis of a case study. This analysis shows that there are three different circular loops in the concrete industry, in which the demolition companies, waste processing companies, construction companies and concrete producers play a role. Furthermore, based on the inter-firm network analysis, it can be concluded that constructions such as joint ventures and strategic partnerships mainly occur in the linear economy, in this case in cement production. Horizontal collaborations have been found between waste processing companies, which process concrete rubble from buildings, and the infrastructure sector, which therefore works intersectorally, and collaborations between construction companies and engineering firms. Most collaborations in the inter-firm networks are vertical. However, these partnerships are peculiar, as described in the data synthesis, because they are location dependent, making it difficult to build long-term partnerships. It can therefore be concluded that the inter-firm networks in the concrete industry are very diverse and dynamic.

### 3. *What are the opportunities and problems of glocalization in realizing a circular economy in the construction sector?*

From the interview results, a total of 380 quotes were coded, of which 217 were opportunities and 163 problems related to CE in the concrete industry. In the data synthesis, 3 paradoxes of glocalization are formulated, consisting of a total of 17 shifts regarding institutional and regulatory arrangements and economic activities in realizing a CE in the concrete industry.

In the discussion, in 6.3, it is described why it is difficult to formulate an unambiguous answer for this sub-question. This has to do with the fact that the problems of glocalization for one company can be an opportunity for another company in the same inter-firm network. For example, where some find it a problem that the sales market for circular products is too small, others see an opportunity to seek collaborations to reach a larger market. It is also possible that what a company sees as a future opportunity is still a problem at the moment. As an example, rising material costs are an opportunity for circular product manufacturers, as their circular products become more attractive to clients, but at the same time, the relatively low costs for new products are currently still a problem, because

there is no financial incentive to opt for circular products. Therefore, the most accurate way to answer this sub-question is by referring to the individual paradox descriptions in 5.2 through 5.4 in which the opportunities and problems are described in a nuanced way.

4. *How do inter-firm networks exploit the opportunities and address the problems of glocalization?*

In the paradox figures where the responses of the network to glocalization are filled in, it can be seen that the actions of the actors in the network are divided into proactive, reactive and inert actions. The paradox of growth figure shows that various proactive actions are taken with regard to the influence that the client has on the demolition process, in particular by trying to remove the financial problems surrounding circular demolition. It is also pointed out that the different attitudes towards glocalization in the infrastructure sector can lead to innovation and a shift to a circular way of working in the future, but that until then it will remain business as usual. The paradox of co-opetition figure shows that actors mainly take reactive actions, by only reacting to one aspect of the paradox. This can be seen, for example, with demolition company D-C, who takes actions to remain competitive, but does not take actions to cooperate with other actors in the inter-firm network. The paradox of long-term/short-term figure shows that adopting a long-term perspective results in a proactive attitude. For example, actors want ambitious standards for concrete production faster, in order to have a lot of impact in the long term. It can also be concluded that the market is experienced with regard to dealing with a long-term and a short-term perspective with regard to investments. This can be seen in the fact that companies have a proactive attitude and make investments in the short term to reap the benefits in the long term.

5. *What are the practical implications for inter-firm networks of a glocalised circular economy?*

The research does not reveal any general clear trends as to what the practical implications are for inter-firm networks as a whole of a glocalised CE. However, statements can be made about possible implications on the basis of the paradox figures from 5.6. The paradox of growth figure shows that waste processing companies may also be able to start producing concrete, because of the high demand for the product and the secondary raw materials that they already have available from their own process. The paradox of co-opetition figure shows that collaborations can arise between companies that perform the same activities, for example by setting up shared marketplaces, or that collaborations arise between companies that follow each other's processes, such as demolition companies and waste processing companies. The figure of the paradox of long-term/short-term shows that a way is being sought to explore the long-term market potential, in order to make it possible to invest in the CE. In this specific case, the motivation behind doing this was so that a possible collaboration could be formed between a demolition company, concrete producer and engineering firm to supply circular concrete products to the infrastructure sector.

Returning to the main question, it can be concluded that the actors within inter-firm networks still have different attitudes towards the paradoxes of glocalization in realizing a circular economy in the construction sector. The three attitudes shown towards the paradoxes of glocalization that have been identified are: proactive, reactive and inert. In the study, this was derived from the various actions being taken by the actors, such as feasibility driven actions, innovation, business model adjustments and legal actions. The research shows that different attitudes to the paradoxes of glocalization can drive changes in the inter-firm networks, such as business expansions, new partnerships between companies that have similar activities, and new partnerships between companies that have different activities but are working on one resulting product.

## 8. Reflection

In this thesis there have been a number of important moments for reflection. Firstly, it was important to find a scientifically and socially relevant problem within the framework of the Master Management in the Built Environment themes. As this thesis takes about 9 months to complete, it is of utmost importance that this topic connects to the authors personal interests in order to be able to research the topic with full intrinsic motivation. The theme of circularity was already known and there was already a lot of interest in it, which ensured that there was a high motivation to learn more about it and to do specific research. Glocalization, on the other hand, was a challenging abstract concept, requiring much further investigation and assistance from the supervisors early in the study. During the thesis, however, this concept has become increasingly clear and the effects have also quickly become apparent after the current affairs surrounding the Ukraine war, such as various price increases (Bouwend Nederland, 2022).

Another important moment was the transition from literature research to data collection based on interviews. The timing was of great importance here, because conducting exploratory literature research has to be completed or stopped at some point. Continuing with the literature search for too long can cause time pressure at the end of the process, but stopping too early carries the risk that insufficient knowledge is gained from the literature. Ultimately, there was enough time to sufficiently complete the literature review and to conduct the interviews, but in this study it might have been better to opt for an approach as described by Dubois and Gadde in which the various aspects, case, empirical world, framework and theory, are alternated throughout the study (2002). This could have provided the opportunity to start with data collection earlier, after which it could be tested whether the data analysis phase of the research had been set up properly. In the current process, the data synthesis started quite late in the process, where many ad hoc choices had to be made.

The data synthesis was a major challenge. During the synthesis, so much information had to be checked, processed, interpreted, correlated and summarized that methods were needed that could help. Methods have been used, such as the use of the matrices and network figures, whereby no research has been done into the applicability of the method for the purpose of the data synthesis. In retrospect, this has been an incorrect approach and should have been better researched in the methodology beforehand. Ultimately, the synthesis with these methods is completed, but the thesis does give the recommendation to look more closely at this in the future. The fact that the supervisors could view the data more 'from a distance' helped to find the common thread in the data, such as the categorization of the paradoxes that was used further in the study.

In the thesis, of course, the conclusion must provide an answer to the research questions that were formulated at the start of the research. However, when the research questions were formulated, there was insufficient knowledge about glocalization and the case study was still unknown, which made it difficult to draw possible conclusions and to check whether the formulations of the research questions were correct. In the current process, the research questions have remained unchanged and in retrospect it appears that sub-question 3 in particular is difficult to answer, as described in the discussion. In addition, the variety of data and information is so extensive that the answer to the main question is still very broad. In the future, it is wise to pay more attention to what kind of answers are expected to be obtained from the research.

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## Appendix A: Interview datasheet, institutional and regulatory arrangements

ID	Quotation Content	Codes
1:1	for that you have to adjust the demolition process slightly and that starts with understanding; what is actually in that building?	Local Waste management, problem
1:2	we prevent ourselves from being affected by all kinds of trade restrictions	Global Market for secondary raw materials, opportunity
1:3	CO2 pricing models	National Production, opportunity
1:4	For some materials, you can reapply them one on one	Consumption, opportunity National
1:5	For other materials you will have to do something to make a new usable, certified and guaranteed product out of it	Consumption, problem National
1:6	According to the current building decree, a wooden frame that you remove from an old building can no longer be placed in a new building, because it is not high enough. So you have to adjust that first	National Production, problem
1:7	Our concrete has demonstrably low environmental costs, demonstrably low CO2 emissions	National Production, opportunity
1:8	We certainly do not want to have that in the biomass installation for a little energy	National Waste management, problem
1:10	We make facing bricks, so new bricks from ceramic waste. There you actually just bake new facing bricks that look exactly the same, have the same certificates	National Production, opportunity
1:11	Bitumen from bitumen	National Production, opportunity
1:12	I would really like to make the warehouse in the Netherlands more transparent	National Waste management, opportunity
1:13	Of course we do this at a micro level as an SME building by building and we have now reached the point where we have a volume with which we can initiate a significant process change	Local Waste management, opportunity
1:14	but of course I would prefer to just map the portfolios of housing associations and investors, to clarify what that urban mining potential is	National Waste management, opportunity
1:18	Current trade restrictions and crisis make international transportation of material difficult	Consumption, problem Global
1:22	that mainly results in independence for raw materials that we do not have as the Netherlands, and which we now have to import from all countries. Well, I think a bit of independence is very important	Consumption, opportunity Market for secondary raw materials, opportunity National
2:6	nowhere in the statutes of a housing corporation does it state that they must be the owner of raw materials. They must facilitate social housing and if they can do that in a way, sober and effective, that is better than the current model, yes, then that is also allowed without raw materials on the balance sheet.	Consumption, opportunity National
2:12	all kinds of requirements come to the construction industry about how those materials, which are owned by people with savings, may be applied. And yes, then you will create detachability in buildings and that will be the biggest driver for a circular economic model.	National Production, opportunity
2:13	then I hope they've incorporated this dimension into their decision-making, that they understand that they can already make choices that aren't necessarily more expensive or take longer.	National Waste management, opportunity
3:1	but unfortunately there are still materials in buildings that we do not want or cannot reuse. Then you have to think in particular of asbestos and other contaminants.	Consumption, problem National
3:2	the Dutch government does not really have a solution for that yet. So that is now stored by the Dutch government. So we actually hand that in to the government, and they store that.	National Waste management, problem
3:3	One of the properties of asbestos is that it does not burn very well. There is also not really any other processing for it yet and for the time being it is indeed stored by the government, yes.	National Waste management, problem
3:4	Wood comes in 3 qualities. You have AB and C wood. And, depending on the quality of the type of wood, processing is sought. So some of the wood is processed in MDF but some is used as fuel as well.	National Waste management, opportunity
3:5	Absolutely, so before we start demolishing, we naturally look very carefully at, yes, which building components in this building can be reused directly? And so we have two dismantling teams, who do nothing all day but disassemble those things, possibly edit them and ensure that they find a place somewhere again.	Local Market for secondary raw materials, opportunity
3:6	So we now have a bit of that too, in itself in the trade in used building materials, which is as old as demolition itself. And what you see now is that, especially due to digitization, this is simply finding its place more and more. For example, we have now also set up a webshop for those used building materials and you can really see the interest in those materials growing. You now see architects really focusing on designing with used building materials	Market for secondary raw materials, opportunity National
3:7	the more you separate, the more profitable it is. Copper is of course an example of what is well separated, but also all metals and actually at all, wood itself is simply separated, that is simply worth something different than at the moment when it is all put together. Separating waste always pays off in that respect	National Waste management, opportunity
3:8	As much as possible at the source when it works	Local Waste management, opportunity
3:9	when it doesn't, so indeed afterwards with our sorting centers.	National Waste management, opportunity
3:10	So indeed, those insulation materials, where possible we simply remove them 'as is' and try to bring them to other projects in that way.	National Waste management, opportunity
3:11	You also have recycling programs for rock wool, but even then, a huge amount of energy is involved.	National Production, problem
3:12	So there is a bit of caution on the demolition site itself, I would almost say, because the moment it has to be concrete granulate, then it has to be really clean concrete. So nothing else or hardly anything else should be in it, so that often requires careful demolition. And indeed, after that it has to be broken to a certain grain size, sieved, sometimes even washed, so there are still quite a few steps behind that.	National Waste management, problem
3:13	So normal mixed granulate, that is relatively allowed, so there may be brick in between and that is allowed, it must of course be broken, but it does not have to be sifted, for example, or hardly at all. That also does not need to be washed	Market for secondary raw materials, opportunity National
3:14	But the moment you really go to the concrete granulate for the concrete industry, well, that really requires a different quality, so that requires considerably more processing. So that certainly costs energy money, yes.	National Production, problem
3:15	what we're trying to do is do that operation in the demolition site as well	Local Waste management, opportunity

3:16	yes and so indeed, if you just have to bring granulate to Groningen from Rotterdam, your margin will disappear again. 00:13:04 Axel Hendriks But nobody does that.	Local Waste management, problem
3:17	Yes, you see, we are currently building so many roads throughout the Netherlands that there is actually a shortage of mixed granulate on the market. 00:13:37	Market for secondary raw materials, problem National
3:18	Of course you have to lose it somewhere, so just under a road. 00:14:15 Axel Hendriks Yes, of course, yes, it is.	Market for secondary raw materials, opportunity National
3:19	You see, for the concrete industry, you can indeed use concrete granulate there as a gravel replacement, provided that it is sieved to the right size, washed and so on.	Market for secondary raw materials, opportunity National
3:20	But you do indeed see that the demand side, in other words, the road construction side, is now so great that there is sometimes a tension between, yes, I have the granulate fine, but will I work it up into a raw material for the concrete industry? Or, well, I literally send it to road construction. That field of tension is indeed caused by the big questions on the side of road construction.	Market for secondary raw materials, problem National
3:21	we are working on reprocessing AEC granulate. Waste-to-energy plant, meaning literally the bottom ashes that come from the power plants as residual material, can be processed and washed into a freely applicable building material and then used, for example, instead of concrete granulate as a building material in road construction.	National Production, opportunity
3:22	And they were actually interested in materials that came from our building.	Local Market for secondary raw materials, opportunity
3:23	Together with the IMD engineering firm, we looked at how we can design that building in such a way that literally those steel elements, ie those beams and those T-struts, can be used again in the new building 500 m away.	National Production, opportunity
3:24	So you actually skip the entire step of the blast furnace, because you literally saw that element loose and you screw it back together 500 m further on	Local Waste management, opportunity
3:25	But that also means you couldn't take that building apart with your crusher? 00:19:11 Axel Hendriks Indeed, it also means a lot to our operation and the guys who work there.	Local Waste management, problem
3:26	Yes, it is extra work	Local Waste management, problem
3:27	they also see, you know, that it is very special and that it is very cool	Local Waste management, opportunity
3:28	on the other hand there is always some kind of time pressure. A project just has to be finished. There are big cranes, there are big machines working, and people too.	National Waste management, problem
3:29	We have been given plenty of time for this by this client. Or not all the time, but at least got a little more time to work on the project.	Local Waste management, opportunity
3:30	Yes, this costs extra, but you are indeed in a different way, you are indeed sawing things loose, instead of squeezing and at the same time also yields a lot.	Local Waste management, problem
3:31	They save € 550 per tonne. 00:20:48 Axel Hendriks Exactly	Local Market for secondary raw materials, opportunity
3:32	And of course you can use that amount for a bit of extra work on our side on the one hand and a bit of work on their side on the other hand, because on their side a steel worker really has to assemble the entire construction	Local Market for secondary raw materials, opportunity
3:33	so you will work much more carefully	Local Waste management, problem
3:34	But in this case, because we were already going to demolish Japanese, those costs were fairly manageable	Local Waste management, opportunity
3:35	of course we have to and we are of course working hard on a model where that is no longer a coincidence, but that we know exactly that yes, we are going to break this down in period x and in that same period something will be built somewhere, wait a minute, what can we coordinate? 00:21:37	National Waste management, problem
3:36	Yes, digitization	National Waste management, opportunity
3:37	the trade in used building materials, as I just call it, used to depend, until six months ago, on the network, so from people we knew, people we had the phone. We knew if we had doors we should call them. If we had sanitary facilities we had to call them and so on.	Local Waste management, problem
3:38	I think we have now taken the first step with a webshop. So we've started putting all the materials we have in stock online and what we're doing now is putting materials online that are still in buildings but will be available in a month or two	Local Waste management, opportunity
3:39	And that of course also means that you save on transport, which saves you action, because then you don't first take it to storage, but then you can actually go directly from the old project to the new project	Local Waste management, opportunity
3:40	The next step is of course that you cannot look ahead one or two months, but one or two or 3 years. You know, then designers can also start designing better with materials that become available.	Consumption, opportunity National
3:41	Look what still often happens is that a designer or an architect designs something. Then he will look for the materials, while ideally he will naturally design with the materials that are available. And for that you have to be able to look ahead for more than one or two months.	Consumption, problem National
3:42	you somehow ensure that the materials that are released are stored for years until those builders need it. 00:25:36 Axel Hendriks And the latter is a little bit what is happening now, but you can see that it adds costs.	Local Market for secondary raw materials, problem
3:43	Because you have to build a building to put down all those steel beams. 00:25:44 Axel Hendriks Exactly. Yes, literally.	Local Market for secondary raw materials, problem
3:48	Whether we have to supply all those hinges ourselves, say, or whether we do this through our partners, but of course you see that more and more materials that are released at our buildings are also given a second life.	Market for secondary raw materials, opportunity National
3:49	we have now started a sawmill in Amsterdam this month. We bring wood there that we obtain from demolition projects. This is then sawn into new wooden products. Well, we will sell some of those wooden products ourselves, but the main flow will go via Pontmeyer in a moment.	Market for secondary raw materials, opportunity National
3:50	The stand builder did not want to take them back so we now have to throw them in the mixed construction and demolition waste bin. We don't really want that	Local Waste management, problem
3:51	the moment I actually get to someone's process, so you know like in Leiden and you know, I will of course cycle through the regular process a bit. And of course people sometimes say, yes, but Axel, that takes a lot of time and a lot of extra work. What are you doing difficult?	Local Waste management, problem

3:52	because the moment you indeed start to spend way too much time dismantling a certain material, yes, yes, then there comes a moment when you just don't have to anymore to do.	Local Waste management, problem
3:58	I think it also pays to test the environmental impact of buildings and to really make that part of, for example, a building permit application	Consumption, opportunity National
3:59	Well, it's being experimented with very carefully. You have the MPG called it I believe, environmental performance buildings. I think it's there now, but it's not being enforced	Consumption, problem Local
3:60	Because it's actually really complicated to measure it and that's what they're still really struggling with	Consumption, problem National
3:61	So there is some sort of standard. But reuse, for example, is not yet part of this.	Consumption, problem National
3:62	the environmental impact of a building and of all the materials that are in it, the shadow costs actually involved, yes, that is just enormously complicated and enormously complex. This means that there is still resistance there against the really hard introduction and enforcement of that standard	Consumption, problem National
3:63	because if a standard is enforced, yes, then it must also be very clear.	Consumption, problem National
3:64	very hard work is being done on a uniform standard in order to immediately measure the environmental impact of a building and what that will ultimately be, I don't know yet, but we are working very hard on it by different parties at different levels.	Consumption, opportunity National
3:65	I do think that is a very important solution, because then you can indeed determine that standard at a given moment and then start phasing out. That you can literally take steps at a given moment, just like the energy efficiency of houses.	Consumption, opportunity National
3:67	The moment something just has to have a low environmental impact, so you have to use used building materials, otherwise you will not get a permit and then you will steer on other points.	Consumption, opportunity National
3:69	But who should do that? 00:36:15 Axel Hendriks: Yes, I think the government.	Consumption, opportunity National
4:1	So the materials that are released here in Alphen aan de Rijn, for example, that a construction company here in Alphen aan de Rijn will also process in its project.	Local Market for secondary raw materials, opportunity
4:5	but in principle you did from the start you kept wooden beams separate	Local Waste management, opportunity
4:6	Only, when it comes to the materials that come out, I don't have the data that a construction party needs	Local Waste management, problem
4:7	When it comes to laws and regulations, yes, I cannot guarantee.	Consumption, problem National
4:8	that's great that the report states that it is reusable, but yes, our network is not up to it. And also a network of another demolition company, although I invite 30 demolition companies, they all do not have the network to sell those doors, for example as a door.	Market for secondary raw materials, problem National
4:11	with such a beam, whole studies are being done. How long can the concrete last from before? Well then a beam is drilled completely to pieces, or at least they drill holes in it and then they check whether there is concrete rot in it. Is it still possible?	Consumption, problem National
4:12	I think that in the future there will also be hope in the reuse of concrete in its element, so to speak, instead of crushing and breaking it into new, applicable material.	National Production, opportunity
4:14	if they say yes, housing is needed and there is a large office, then I cannot put those floors from, for example, the floor panels or the concrete elements from that office building in those homes. Because then you have to deal with load on the floor and how much power per square meter can you have? And of course you have different standards in a home than in an office building. So yes, that is very difficult.	National Production, problem
4:16	If you say now, I'm going to reuse hollow core slabs. The market is not really there yet. Because I think that if I now saw all hollow core plates loose and put them away, I wouldn't really have a buyer for it in 10 years' time.	Market for secondary raw materials, problem National
4:18	it is true that if we start sawing something loose, then you don't have to clean up much, for example. You are standing with a crane, you are sawing loose. You are not first chopping down that viaduct with a demolition crane and then you still have to shovel everything away and drive away, well, now you take out a beam, you unload it, you saw it out, it goes on transport, that goes away at once. Yes, so that is more efficient. Costs more, but it is more efficient.	Local Waste management, opportunity
4:19	Well, then comes the breaker, it comes once or twice a year. He breaks that entire loft into the granulate again. And, that is reused.	Local Market for secondary raw materials, opportunity
4:20	Yes, because the market for circular concrete granulate, or at least for gravel replacement, is not yet very large. Because you are also not allowed to use a lot in new elements.	Market for secondary raw materials, problem National
4:21	There is also a bit of impediment there, because I think only 20% should be in load-bearing constructions by heart, but yes, almost 90% of the construction is load-bearing construction, which is exactly what you make of concrete.	National Production, problem
4:22	We prefer that if it cannot be reused as an element, it should be broken up again into a gravel substitute.	Market for secondary raw materials, opportunity National
4:23	I can't always bring what lies here to Theo Pouw and say, it has to be reused as circular gravel or as a gravel replacement. Because, then he also says yes, that's possible, but then I have to produce a huge amount of concrete. And that may not even be all in all elements.	Market for secondary raw materials, problem National
4:24	but of course they also want to hold back a bit, because if something happens in 10 years' time to a building that contains more than 20% gravel replacement, that is of course a bit of a disincentive, yes, we're not going to put too much into it	National Production, problem
4:25	but it's more like looking more at the non-constructive elements. Where can it be 100%?	National Production, opportunity
4:26	that collaboration was once, that has been a long time ago, that combination that we could make that gravel replacement, that started together with Theo Pouw	Market for secondary raw materials, opportunity National
4:27	We always try to separate the concrete from the masonry rubble as much as possible, so that it can then be used as a gravel replacement.	Local Waste management, opportunity
4:37	Of course you have to do those studies, you have to be sure that you can really reuse those things and also provide some sort of warranty.	Consumption, problem National
4:40	but we're looking at how we can make this the standard. That if a demolition contractor is instructed that a viaduct has to go, that instead of making a price to demolish, you will make a price for dismantling. It should also just be a standard story. It is, so to speak, the example that should soon become standard.	National Waste management, opportunity

4:44	an English demolition company is now also working in Nijmegen and it works very differently from a Dutch demolition party.	Global Waste management, problem
4:45	So yes, laws and regulations, look, we have a separation obligation here. We are obliged to separate glass. We are obliged to separate wood. We are obliged to separate bitumen. Yes, concrete or masonry rubble can be separated, so to speak. We do not demolish buildings abroad, it is often just bridges, so of course you only have one waste stream and that is your concrete or steel or that sort of thing. But I think maybe abroad you might have a lot more requirements with separation standards and things like that.	Global Waste management, problem
4:46	Look in Germany they have different rules for waste flows. Look, we can no longer call it waste here, for example. Well, you know what I mean, but if you say something about that, yes, but I'm going to reuse it, they say, but how do you get your waste flow number? Or how are you going to prove that it has been removed. If I dispose of air conditioners, for example in Germany, I am going to demolish a building with air conditioners in it, and I say yes, I sold those air conditioners, they say yes, but how is that possible? Those air conditioners contain toxic gases, what have you done with those air conditioners.	Global Waste management, problem
4:47	Yes, the waste processors in particular are looked at in advance, so the PreZero, Renewi, the large waste processors, you always go there to see who is nearby? Then you also know a bit about the rates. Because then you know by now if that distance from there to there is this, right? That is how it is calculated from yes, we have to drain and then it has to go there	Local Market for secondary raw materials, opportunity
4:48	But for me it's more like, well, if there's a network, if it's in Utrecht, for example, then I know, well in Utrecht I have such and such, and they want to come there.	Local Market for secondary raw materials, opportunity
4:49	Of course, if it's somewhere in Groningen, those people really don't come to Groningen.	Local Market for secondary raw materials, problem
4:50	because sometimes you have a lot of private individuals in a certain region that you know about, just like here in Alphen I must say, you also have those farmers here, who then want to have a few beams, or a little wood or something like that. Well, you just have very good people there, because you know for sure that they will come and pick it up, they pay and you just keep in touch with them.	Local Market for secondary raw materials, opportunity
4:51	But I also have parties in the major cities that purchase large bundles. Only, that differs very much from yes, as material reuse, you can have parties that grind it up again.	Market for secondary raw materials, opportunity National
4:52	we also have to return it to the supplier, so with Forbo, for example. So that yes. You try to find more and more chain partners.	Market for secondary raw materials, opportunity National
4:53	Yes that is still the case with waste and with me it is really like well, then you go and see who is sitting around there? Or at least, who is in my network who can buy stuff in the Utrecht region, for example?	Local Market for secondary raw materials, opportunity
4:54	Because a real estate entrepreneur who says yes, that building has to go as soon as possible and I have to build houses as quickly as possible.	National Waste management, problem
4:55	But the municipality that says 'joh', take your time, make sure that it is done in accordance with the market price, but you will get a little more time.	National Waste management, opportunity
4:56	But I must say that this is also region-specific	Local Market for secondary raw materials, problem
4:57	You also have to deal with footprint and things like that with certain tenders. So that you have to look at what those CO2 emissions are, so of course try to sell as much as possible locally.	Local Market for secondary raw materials, problem
4:58	Beelen next is really the workshop and the sale of materials and of course they are a very large waste branch and therefore they do the breaking and processing all the waste themselves. They have it all under their own control.	Local Waste management, opportunity
5:1	WP-B started collecting construction and demolition materials about 40 years ago and then deposited them as underlays, ballast layers, for roads and that kind of pavement	National Waste management, opportunity
5:4	we have a thermal cleaning installation in Eemshaven where, for example, polluted soil or tar-containing asphalt or all those kinds of products are removed through the entire installation. It just actually burns. What you then have left is, of course, granulates, i.e. aggregates. This can then be used for new concrete to be applied. But there is also a residual product left behind, let's say a kind of substance. This is captured by dust filters. And that is of course what people are looking for: can I do something with that dust? Part goes to the cement industry and part is what we then use	National Production, opportunity
5:5	And so we're a bit active all the time to watch, hey, we're getting something in somewhere, we have a waste stream, what can we do with it?	National Production, opportunity
5:6	the concrete industry, the cement concrete industry, it is boarded up. Everything has been closed through regulations. There is very little that can be done.	National Production, problem
5:7	you have to fully demonstrate in advance what is possible or allowed.	Consumption, problem National
5:10	People in the cement and concrete industry are a bit, yes, what do we call that, conservative.	National Production, problem
5:11	The government's demand is increasingly for lower CO2 emissions.	Consumption, problem National
5:12	cement, that pure Portland cement that comes from a cement manufacturer, has a heavy CO2 load, that's just the case, we can't do much about that. And as a result, we also have a reasonable CO2 load on the concrete products industry. The question from the government is: how can we all bring that down?	Consumption, problem National
5:13	Then of course Bouwend Nederland comes to the concrete plants with the question: yes, and what are you doing to bring that down?	Consumption, problem National
5:14	Well, then there is a new development, which is concrete without cement. They call it geopolymers concrete as a collective name	National Production, opportunity
5:15	they have actually been asked, well, can we do concrete there without cement? to experience? So we started with that two years ago and the result is that at the moment there are two bridges, a bicycle bridge and a road bridge	Local Production, opportunity
5:16	The municipality of Almere says: we want to be nice to the Floriade. We want to show you something. We want something innovative	Local Production, opportunity
5:17	After a long talk, everyone is enthusiastic, but then there has to be a signature somewhere. Then someone at the town hall wakes up at five to twelve and then he thinks, oh yes, I should actually sign, but what do I put that signature for? And then people shudder. What have we done in the meantime? I was asked: can we put that on the market certified and already?	Consumption, problem National

5:18	we just did that just to show that the concrete without cement, let's say on the same level as concrete with cement, so we had various tests used by various people just to demonstrate: it looks looking good, we are on the right track. And based on that, a certification process is started	Consumption, opportunity National
5:19	When we started delivering that concrete for those two bridges, we were simply certified. In other words, for the contractor there was no reason to say, we see a problem or anything like that.	Market for secondary raw materials, opportunity National
5:21	And of course there will come a day and then we will sit together and then we will look at: how can we join forces to be able to offer an alternative product in addition to concrete with cement	National Production, opportunity
5:22	This is local. In this case it is local, because this case concerned the Floriade.	Local Production, opportunity
5:23	Because, on the one hand, Rijkswaterstaat is naturally quite interested in something like this	Consumption, opportunity National
5:24	if we want to apply this on a large scale as Rijkswaterstaat, then it must be properly secured. Then we also have to be sure that if we make such an element from that new concrete, it will remain in place for 100 years	Consumption, problem National
5:35	We then use part of it to start producing new products and part of it is returned immediately as road construction foundations.	Market for secondary raw materials, opportunity National
5:36	they have set the ambition to replace 5% of the primary material with concrete granulate or secondary materials	Local Production, problem
5:37	I can already tell you, we use 50%	Local Production, opportunity
5:38	In my previous job I worked at the Concrete Plant, which in 1970 was already using 20 to 30% concrete granulate. We are 2022. What progress have we made?	Local Production, opportunity
5:39	Do you want to use all of that for the concrete industry and you want, say, nationally to 30 or 40% reuse. Then the stream that goes under the road, that amount, it can no longer go under the road, because otherwise there will be too little concrete rubble granulate. That's actually the reason it's not always available	Market for secondary raw materials, problem National
5:40	If I want to use that material for the concrete industry, it has to go through sieving and all that sort of thing. That costs extra actions and that naturally increases the price of the granulate. So the moment you do that, you have to put it away in high quality.	Market for secondary raw materials, opportunity National
5:41	In fact, there is a little too little concrete rubble granulate in that regard to fully supply the market.	Market for secondary raw materials, problem National
5:42	We are now talking about concrete rubble granulate, but the general term is secondary material and secondary material can also be railway ballast, for example. That's what we do a lot here. Rail ballast is regularly released from the track. That comes here on our site. Those are quite big chunks and of course there is everything in between. We are going to break that, we are going to wash it and then we will get clean rail ballast out of it. And I can use that as a gravel replacement for 80%. It's just really good, hard, dense material. That is also part of recycling of course, it does not always have to be made of broken concrete. It can also come your way in other ways.	National Production, opportunity
5:43	rail ballast are also just hard stones and there are many more products that you can use.	National Production, opportunity
5:44	Yes, because if you can? That's great, but if it is allowed and that is often a bit with the regulations with the cement and concrete industry, it is not always allowed.	Consumption, problem National
6:2	And, we applied the idea of reusing prefab beams there. Then you are not going to make an entire viaduct circular, but you are making use of the possibilities that Rijkswaterstaat itself introduced 40 years ago because they have started to work in a modular way.	Consumption, opportunity National
6:3	. And, there is a whole circus around it. All kinds of resistance to overcome. Resistance that have to do with regulations that have to do with residual lifespan, with aesthetic aspects, licensing matters.	Consumption, problem National
6:4	showing that it is not only possible, but we also guarantee proper functioning for another 100 years, so it will all work out.	Consumption, opportunity National
6:6	About 15 years ago there was a whole unit that was only concerned with sustainability, but the market was not yet ripe for that. So you notice that people in our company wanted to help the customers, but those customers didn't want to be helped.	Consumption, problem National
6:7	An important resistance was the idea that beams were designed about 40 years ago with the standards of 40 years ago. Logically. And they no longer match today's standards.	National Production, problem
6:8	The Eurocode has been implemented, so the calculation methods have changed and the assumption is that they do not match.	EU Production, problem
6:9	We have shown that there is so much residual capacity in those beams that they still meet the new-build standards even now. So that answers your question, how did you deal with this resistance? By showing that it is still good.	Consumption, opportunity National
6:10	so through that factory process which is fully certified, we are covered and strengthened in demonstrating that those beams can still last a very long time.	Consumption, opportunity National
6:11	Well, the next resistance is that an administrator doesn't believe it.	Consumption, problem National
6:12	Rijkswaterstaat even has the ambition to work circularly by 2030 and to be circular by 2050.	Consumption, opportunity National
6:13	Oh yes, the regulations and licensing. So you have a municipality that has to grant a permit. We also included that municipality in the entire process and they simply issue a permit for the new structure,	Consumption, opportunity Local
6:14	but that whole new assembly, that is neatly calculated. This is where these lie. That is just approved. Well, in this way we are convincing by simply proving that it is correct	Consumption, opportunity Local
6:15	You have to imagine that everything that is being designed at the moment is still based on the use of new materials. So there's actually very little available in terms of regulations regarding the reuse of materials. That has to be developed and we are on the eve, we are at the beginning of that development.	National Production, problem
6:16	And that's not just existing materials, which have been demolished and completely crushed and put back in new concrete. That is also possible. 25 years ago we thought that it was sustainable, that recycling.	National Waste management, problem
6:17	In a number of cases, we can demonstrate with recalculations that a viaduct that has been rejected simply meets the requirements, because people have not calculated accurately enough.	Consumption, opportunity National
6:18	But if that has to happen and a viaduct has to disappear, we say okay, disassemble it, disassemble it instead of demolishing it. And use it again for a purpose for which it was made and that can apply to the beams.	Consumption, opportunity National

6:19	Yes, giving filling in actually means making a proposal to a standards committee. Then you must be represented in that standards committee. You need to be heard and we're represented and we're bringing it in.	National Production, opportunity
6:20	But the new standards are not yet there. Those that are being developed, but that's something that takes time.	National Production, problem
6:21	But the great thing is that in the meantime we have demonstrated that beams 40 years older even meet the new-build standard. So it wasn't even a matter of a different standard there. So they even meet that new-build level.	National Production, opportunity
6:22	So we wanted to enter into a discussion of, shouldn't you judge this against the level of renovation.	Consumption, problem Local
6:23	For example, you have the CE approval. So the European Union prescribes that every element that will be applied must have a CE mark.	Consumption, problem EU
6:24	we say, but these beams were already there. Cars are already driving over them. So they already met, so they don't actually need to have a new CE mark. So we managed to avoid that that way. So far it's going well.	Consumption, opportunity EU
6:25	There will probably be a smart person on it who says, well, on closer inspection I think that it must still meet a CE mark, but they have to say that in Europe. And yes, I think we are still quite ahead of those circularity thoughts in the Dutch market. And I don't know how far they are in Europe with that.	Consumption, opportunity EU
6:30	1/3 factor is the incentive that clients have to work in a circular way. That is the MKI assessment. So one of the EMVI criteria that is often used is that the MKI balance must be good, so that you are rewarded if you use few raw materials and use little energy and emit little CO2. Then you have a low MKI score and a low MKI score means you get a lot of deductions, so you get the fictitious rating there.	Consumption, opportunity Local
6:31	That's a really difficult thing. We notice that the EMVI valuation for this aspect is not yet sufficiently developed for this aspect	Consumption, problem National
6:32	Often it is on the other side. So if you use reusable materials in a new project, yes, then you have the advantage that you need few new raw materials and need little energy and low CO2 emissions. So the biggest MKI advantage lies with the receiving party	Consumption, opportunity Local
6:33	The receiving party does have all kinds of other thoughts, such as it is not strong enough and not durable enough, it can last long enough, but we have now demonstrated enough that it is.	Market for secondary raw materials, opportunity National
6:34	But that EMVI advantage, the MKI advantage is actually in receiving the viaduct, but you have to harvest them first. So we have noticed that in order to harvest them, an extra incentive is needed and we are now discussing with major clients, including Rijkswaterstaat, how we can achieve this.	Consumption, problem National
6:35	And that actually means that they should pay more attention to this in their contracts. They should appreciate that more. Because now it is actually the case that materials released in contracts revert to the contractor and the contractor can do what he wants with them.	Local Waste management, problem
6:36	And that one is just on the cent, shall I say, it chooses the cheapest way. If it's over land, and there's no time pressure on it, they'll just destroy them from below. If there is time pressure and he has to act quickly, he may pre-treat them and lift them out. But that's entirely up to the contractor.	Local Waste management, problem
6:37	Well, actually we have to get to the situation where that contractor is encouraged to always disassemble them. Well, that's not the case in current contracts, so maybe in 5 years you'll have the first contracts that state that. So that actually means that the client has to make a turn in prescribing things in his contract.	Local Waste management, opportunity
6:38	Yes, so reused in the project is often tricky. It's the first thing you should investigate. Because if you can keep it within your own work area, that is the most sustainable thing there is.	Local Market for secondary raw materials, opportunity
6:39	Because what we have now come up with is that we take them out. Or if they're in a hoist, we run under a car, put it on that car, and then we make sure it goes away. Then we bring it to a storage yard, then you often have to drive 100 km or so. At that storage yard we take the pressure layer off and we adjust it and then we match it with a new project, which is also maybe 100 km away. Then you have to drive 200 km with that beam. Yes, that is not good for sustainability.	Local Market for secondary raw materials, problem
6:40	Much better to keep it in place and reuse it in the same project. Then you close the circle within your own project, that would be ideal.	Local Market for secondary raw materials, opportunity
6:41	We investigated this for a project. It is often not possible, because the current contract does not allow this and those current contracts have already made agreements with the surrounding parties about the speed of work and the degree of nuisance to the environment and the nuisance for road users. So they are stuck between all the promises they have made and then it no longer fits.	Local Waste management, problem
6:42	We've looked at different situations and we do see opportunities for new projects to do it, but those projects haven't been acquired yet	Local Waste management, opportunity
6:43	And my colleagues are also working on new contracts where you notice that you have to sit a few years before and then you have to think about 5 years. You have to start about that now, with a project that will only be on the market in 5 years.	Local Waste management, opportunity
6:44	in the meantime you have to make do with the current contracts and it just isn't in there. So that's just hard right now	Local Waste management, problem
6:45	A lot of talking and the client must also have the guts to want to change the rules for this with the existing contractor, because he then has that circular ambition. So now it is still more or less unexplored territory and still requires a lot of consultation to get that done.	Local Waste management, problem
6:46	because then our business case can be made more conclusive and then there can also be benefits on the receiving side and even on the supplying side there can be an advantage if the discussion is won, or in a good way, is being conducted, about valuing the dismantling of materials instead of demolishing them.	Consumption, opportunity Local
6:48	But you actually have to look at the combination of the costs, plus the MKI valuation.	Consumption, opportunity Local
6:55	You have to rent that terrain, so you don't want to end up in the situation that you have 200 beams lying there that you will never lose again. If that's the perspective, we're not going to start.	Local Market for secondary raw materials, problem
6:56	So if you make the match and you can take into account the materials that are present at the receiving project. We're not there yet in the civilian world, but we hope we can get there in a few years.	Consumption, problem National
6:58	Actually, our ideal model is that we will continue to exist as a combination of beams 2.0.	Market for secondary raw materials, opportunity National

6:59	In fact, we would prefer to turn this into a company where we become a supplier of reusable beams.	Market for secondary raw materials, opportunity National
6:61	So we're talking to them, how can that market be shaped in such a way that you can make that match between a donor project and a recipient project?	Local Market for secondary raw materials, problem
6:62	And if there is more insight into this and the receiving projects are stimulated to apply these reusable beams, the situation may arise in which we can continue our good collaboration	Market for secondary raw materials, opportunity National
6:64	A model is also conceivable in which we engage Haitsma as a supplier of second-hand beams and that we ensure that these become available with the rest of the consortium, but that we leave the seller to the party that can do this best, and that is the beam supplier.	Market for secondary raw materials, opportunity National
6:65	because he also says, I have a storage yard and should I expand for second-hand beams or should I buy all kinds of storage yard elsewhere in the country?	Local Market for secondary raw materials, problem
6:66	We will also have to set up marketplaces. So a marketplace for second-hand bridges. Can we link a beam bank to it? That market parties can also make that match. So we put there on that beam bank, these become available, who wants them? So that the rest of the Netherlands can also register	Local Market for secondary raw materials, opportunity
7:1	Not so much problems, but there are just laws that dictate what we can and cannot do. One of the most important things is that it is not allowed to use 100% circular concrete. From my head it is allowed to reuse 2/3 of the extracted concrete, so if you are making new concrete, 2/3 of it may consist of circularly extracted concrete, but there must always be 1/3 really new fresh made concrete added.	National Production, problem
7:2	I have spoken to a number of builders in recent days about specific circular concrete and they all say, it is still at such an early stage we are still experimenting a bit and to see what can and to see what can't, how far we can go in this, what works, what doesn't work.	Local Production, opportunity
7:3	So we are not yet very explicitly involved with that legislation and how we want to focus on it and what we want to see changed in it, simply because we are still so early in that whole stage.	National Production, problem
7:4	No, there is no active lobby in the field of circular concrete use regulations.	National Production, problem
7:5	We have been working on it for 2-3 years now that those urban miners are really starting to take off and that the large construction companies are really starting to make use of it. And that's all still at a fairly early stage, so we're still figuring that out. How is it going, how are things going, what can we actually reuse?	Local Production, problem
7:6	Because I also hear from builders that it is often disappointing that they hope to extract so many tons of concrete from a construction project and that in practice it is always disappointing. So yeah, it's just very early stage.	Local Waste management, problem
7:7	There are even companies that do not necessarily already work with recycled concrete, circular concrete, but are already winning. So just store the rubble somewhere on a storage to use it in the coming years, if necessary.	Local Market for secondary raw materials, opportunity
7:9	Concerning concrete that is now being reused here in the Netherlands. In principle, almost all of this is locally sourced.	Local Market for secondary raw materials, opportunity
7:10	Yes, that still happens on a fairly small scale.	Local Market for secondary raw materials, opportunity
7:11	They excavated and drilled out a whole concrete tank there and they did not immediately have a new destination for that concrete rubble at that time.	Local Market for secondary raw materials, problem
7:12	So it's not that they actually store it for a long time, but maybe need it sometime, and that they know that they will soon be setting up a project of their own. That will take a few more months, and they will temporarily store it for a while and then they will reuse it after that, so more like that	Local Market for secondary raw materials, opportunity
7:13	Yes basically positive. Look, every builder agrees that this is the future and some are happier with it than others. But the general tenor on the market is that they are happy with it,	Local Production, opportunity
7:15	So yes, in general people are very positive about this	Local Production, opportunity
7:16	it is often thought that the market wants as little regulation as possible, but in these areas we actually say: just make clear what the plan is as a government, then we will know where we are at. Then you can work towards that.	National Production, problem
7:17	Yes, in principle we are just in favor of that <sup>1</sup> <sub>SEP</sub>	Local Production, opportunity
7:21	And that client said: yes, that's nice, but I'm not going to pay more for it, so if you want that, then you should do that, but it won't cost me anything more.	Local Production, problem
7:23	But it would help if clients themselves were also a bit more at the forefront and thought: gosh, I'll pay just a little more than is strictly necessary to do it in a circular way.	Consumption, problem Local
7:24	As far as we are concerned, that task lies mainly with the authorities, because the government is of course always very vocal that it must be sustainable, but at the same time in our experience with tenders it is mainly that they are insisting that it should be as cheap as possible.	Consumption, problem Local
7:27	it starts with the government. In that sense, they must set a good example.	Consumption, opportunity Local
7:30	On the one hand, the short-term process in which clients have to accept that the prices of circular construction are simply a bit higher	Consumption, opportunity Local
7:33	But you can also see that with the construction hubs that are now being created.	Local Waste management, opportunity
7:34	From 2025 you will no longer be allowed to enter the large cities with fossil fuels. So you actually have to drive to a place outside the city with trucks and transfer everything there to electric vehicles.	Local Waste management, opportunity
7:35	And a few large construction companies have now also said that they will set up these hubs, not only use them for themselves, but other construction companies, especially smaller companies, can sign up for them. They may rent that location from them and use it. And that is how you should do the same with circular concrete. So it seems to us that in a number of places in the country you start urban mines and put that post, which actually every company can use.	Local Waste management, opportunity
7:36	What I don't see is that every company should build its own depot and set up its own men and have to grind that concrete yourself, because that just doesn't make sense. <sup>1</sup> <sub>SEP</sub>	Local Waste management, problem
7:43	This has to do with the fact that the MKI naturally differs per municipality and per client. Everyone can give it their own twist and shop around a bit.	Consumption, opportunity Local

7:44	that plays an enormous role, because the MKI simply determines what degree of sustainability should be used and which goals should be achieved. That can be done very briefly by just using a CO2 ladder and then saying: you have to reduce at least as much emissions. Or it can be very extensive by coming up with a lot of requirements and circular concrete can be one of them. So, that could play a really big role.	Consumption, opportunity Local
7:45	But that mainly depends on how municipalities and clients will deploy MKI. <sup>(P, SEP)</sup>	Consumption, problem Local
8:1	I just need raw materials, I need material flows, which I get from the existing built environment. This requires control of decommissioning processes. We have come to call that urban mining.	National Waste management, opportunity
8:2	A webshop is not an impact.	Local Market for secondary raw materials, problem
8:3	Normally, as you say, the stone-like material from demolition is broken, which is crushed mixed granulate. Pieces are made of it. This breaking technique has only one goal and that is to make large pieces small as quickly as possible.	Market for secondary raw materials, opportunity National
8:4	Koos's technology aims to recover the original raw materials of concrete.	Local Waste management, opportunity
8:6	So you throw old concrete in there, and it comes out: gravel, what ever went into the concrete, the sand, what was ever added to it, the cement, which is hydrated, which is so activated, which is so worked out, that has become glue, but you can also remove cement that has not been activated.	Local Waste management, opportunity
8:7	I think there are several reasons for this, but the main reason is that in the Netherlands we have a standard whereby a certain strength must be reached when making concrete at a certain point in time. And to be sure, just add a little more glue, so add more cement.	EU National Production, problem
8:8	We are now making concrete much more accurately anyway. So with much less cement. And we can even make concrete without cement.	National Production, opportunity
8:9	those raw materials must of course be very pure in order to be able to make reliable products again at the back. So in order to be able to get pure raw materials, and then be able to make reliable concrete, you have to make sure that what you put in that smart liberator is already kind of clean.	Local Waste management, problem
8:10	The way I see it and I'm no expert, but then there's a big bin outside a demolition building and that goes brick rubble and concrete rubble and everything in it? That's where it goes wrong. <sup>(P, SEP)</sup>	Local Waste management, problem
8:11	So you have to separate the brick rubble from the concrete rubble there? Correct. And a lot more than that	Local Waste management, problem
8:12	If you now look at the traditional mixed granulate, it contains: concrete fractions, ceramic material, bricks, sometimes roof tiles, bathroom tiles, but also plaster, which is actually not the intention, but mixed granulate may contain as much as a percentage of non-stony material. There's even plastic in it, there's wood in it, there's metal in it, there's PVC in it. You can actually see that the mixed granulate has become a collection of materials that are insufficiently separated.	Market for secondary raw materials, problem National
8:13	Yes, that's all under our roads.	Market for secondary raw materials, problem National
8:14	And it would be very unwise to try to clean that up if it's all in a pile, so we're going to take that building apart in a controlled way.	Local Waste management, opportunity
8:15	And that means that over the past 2.5 years, together with our partners, we have worked hard on a protocol to arrive at pure concrete from demolition. That already demands something. That requires something from all the phases preceding the constructive demolition. So the moment that crane comes and the building is cut apart, everything is already happening before that time. We are going to clean up asbestos. We remove the inner packages. The technology has to get out of the building.	National Waste management, opportunity
8:16	Most demolition companies are already doing that, but the level of detail at which that happens, the delivery level of that demolition, has to be so much stricter and so much more accurate, in order to retain the value at the back. So you actually add value by making that demolition process take place in a more controlled way.	Local Waste management, opportunity
8:17	Correct, so it really is separation at the source.	Local Waste management, opportunity
8:24	That is still in disguised systems. You have to set a maximum on the environmental performance of your building, the MPG value, and that maximum will be adjusted downwards by the government. Then there comes a time when, in order to get a permit to build, you have to demonstrate that you are below that environmental performance, and that is becoming increasingly difficult. One way to do that is to make material choices that have a lower CO2 footprint.	Consumption, opportunity Local
8:25	You don't have to adapt your design to it.	Local Market for secondary raw materials, opportunity
8:26	You get the same qualifications with the same certification.	Market for secondary raw materials, opportunity National
8:28	If you didn't have this concrete, and the standard says that the MPG will be reduced by 20% in 3 years, if you have to get that 20% saving from building materials other than concrete, then you have to make huge investments. Because the impact of those other individual small building material components in a building is therefore fairly limited, and then you have to make a lot of adjustments to achieve the same savings. Concrete is perhaps the easiest, along with brick, to achieve that saving. And thus it represents value.	Consumption, opportunity Local
8:38	mixed granulate is also released with me, you always keep a fraction that we can no longer get out, yes and there is no other solution for that at the moment than processing in this way.	Market for secondary raw materials, problem National
8:39	then you will have to find an alternative for the foundation of roads.	Market for secondary raw materials, problem National
8:40	You now get all kinds of secondary raw materials when mixed in concrete, which they call neatly, which are actually waste materials from other processes, which we are now going to mix through concrete, in order to be able to say: look, we have so much secondary material in this.	National Production, problem
8:41	Yes, that has been all kinds of slag for many years, so remains from incinerators. Yes, of course you can process it super in concrete. But then it is incorporated in concrete.	National Production, problem
8:42	I would perhaps prefer to have it checked under a road, not mixed with all kinds of pure materials.	National Production, opportunity
8:43	You are right, breaking the current circles means that you have to come up with new solutions.	National Production, problem

8:44	We came up with a model there, in which I decided to collaborate with the established order. This means that we have sought collaborations with various parties that are now distributors of building materials.	Market for secondary raw materials, opportunity National
8:45	I do not believe in all kinds of hubs in the Netherlands where there are spaces with all kinds of used stuff in them	Local Waste management, problem
8:46	So I would like to have my stuff in a warehouse where the new ones are also.	Market for secondary raw materials, opportunity National
8:47	The problem is that we can never supply the full demand from urban mining.	Market for secondary raw materials, problem National
8:48	The demand is huge for these materials	Market for secondary raw materials, opportunity National
8:49	The market has to get used to that urban mining concrete,	Consumption, problem National
8:50	because in principle we give the same warranty as new. And we also always try to meet the same certification as new. So far we have actually succeeded 100%. So all materials we supply have the same warranty, or the same certificate, or the same insured warranty even as new.	Consumption, opportunity National
8:51	The raw material flows that now come out of our smart liberator are classified as secondary material according to the law. That actually means that it is equated to concrete granulate. Concrete granulate is also made as a gravel replacement in concrete and our gravel is actually seen as that concrete granulate. We find that very strange. So we would like to have our materials certified as primary material.	Market for secondary raw materials, problem National
8:52	But it naturally starts with the rules we have around certification that are made, and even partly paid for in a linear economy. No thought has ever been given to what this rule would mean if you want to apply it in a circular economic model.	Market for secondary raw materials, problem National
8:53	I must say that we do find the government on our side here. So Rijkswaterstaat is helping my partner Rutte to complete this certification process.	National Production, opportunity
8:54	he is very decisive in that market and he has declared himself willing to help in this process and to ensure that we have to do this on our own and that she as a future client, customer actually, participate and have an interest, attach importance to a careful certification process of these raw materials. And that helps us enormously.	National Production, opportunity
8:55	because Rijkswaterstaat is of course also a large buyer of that granulate. They are also decisive in creating that demand for granulate. So basically they're playing chess here on two boards. They are helping you with the certification, so that there will soon be less granulate on the market for under their roads. Yes, but I think this is also characteristic of a transition phase.	Market for secondary raw materials, problem National
8:56	You have a kind of going concern in which you have to look for degrees of freedom in order to achieve that transition. So it is obvious that there is a nominal demand for granulate that must be met. We must, however, continue the development of the Netherlands.	Market for secondary raw materials, problem National

## Appendix B: Interview datasheet, economic activities

ID	Quotation Content	Codes
1:9	in fact, there is a large subsidized stream that we actually have to compete against, because people are looking for sustainable energy, and coal-fired power stations can produce green energy if they add a little biomass. Yes, we just want the wood to be able to keep the wood. Yes, so we have to compete against that	Investments and subsidies, problem National
1:15	but also financially an enormous stock	Financial due diligence, opportunity National
1:16	It is precisely through data analyses, that we can determine the urban mining potential and thus provide insight into what is needed to allow investors to make different choices, and to raise investments to realize that innovation	Investments and subsidies, opportunity National
1:17	Predictable volume is crucial for us, that applies to every innovation and we can map that very well with data technology.	National Risk evaluation, opportunity
1:19	it is true that you have to have scale for these kinds of developments, but we are still far from that in the Netherlands	Investments and subsidies, problem Local
1:20	so I am convinced that we can use technologies, as you just saw with concrete, but also with other processes that we lead, can export very well or at least share that knowledge to other countries and perhaps there are also countries where it can be scaled up much faster.	Global Investments and subsidies, opportunity
1:21	We are now working on the first two projects in Germany ourselves	EU Investments and subsidies, opportunity
2:1	what you see is that a lot of value is locked up in our current way of working and in my case it concerns the built environment, a lot of those values are insufficiently recognized. So I think that a lot of healthcare institutions and corporations have real estate on the balance sheet, but do not think at all about the fact that real estate also has a material value in it	Financial due diligence, problem National
2:2	it is up to me for the time being to ensure that that value can actually be realized by ensuring that those raw materials can be converted into new products instead of waste	Financial due diligence, opportunity National
2:3	you see, I think demolition costs are now pushing down project initiatives in a way. And think, yes, listen, we have to, one, write down, and two, we have to incur costs before we can do anything new at all	Investments and subsidies, opportunity National
2:4	So yes, if that is no longer necessary and then there are other people who see the investment value of those commodities, yes, then you can build a healthcare institution for free.	Investments and subsidies, opportunity National
2:5	building something new in the future does not have to mean that you also own all that stuff.	Banking products, opportunity National
2:8	but we have now started with Jones Lang LaSalle in order to include material values in commercial valuations, i.e. in the valuation of real estate and thus actually the worth of those raw material position in the hope that it will develop in the coming years and that I can demonstrate a market with which we can ultimately convert that worth into a value	Financial due diligence, opportunity National
2:9	This is also where it gets stuck in the current linear model of looking at financing	Banking products, problem National
2:10	I don't think we are very far from the moment when at least the dismantling of buildings in the Netherlands is free. Then it still costs money to do it, but then the value you get out of it is at least sufficient to cover the costs.	Investments and subsidies, opportunity National
2:11	I think that within 2.5 years from now we will have commodities funds, in which people will invest, in which we hold positions	Investments and subsidies, opportunity National
3:44	That is of course a shame, because you are still competing with new and new is of course much too cheap, so the moment you have to start storing things, yes, that adds costs and makes your business case even more complicated.	Investments and subsidies, problem National
3:45	What we see, of course, is that when we want to reuse building materials, we have to disassemble carefully. We have to wipe it once, repair it once, then a small edit. And then indeed, well, on transport to our storage and in this case store there temporarily. And of course those are all costs.	Investments and subsidies, problem National
3:46	And labor in particular is of course simply expensive, so relatively much labour.	Investments and subsidies, problem National
3:47	And new is just relatively cheap. If you go to the Gamma or to another construction store, you can buy a door or whatever for a very low price.	Investments and subsidies, problem National
3:53	Certainly considering, again, the prices charged for new. Yes, then it is also just a commercial turning point, where it is simply no longer interesting to disassemble something	Investments and subsidies, problem Local
3:54	As I just said, labor is very expensive compared to raw materials, so that leads to the most bizarre situations.	Investments and subsidies, problem National
3:55	But it is true, for example, that recycled materials, if you calculate it all the way through, are often more expensive than new materials that come from China and are produced en-mass there.	Global Investments and subsidies, problem National
3:56	Well, look that labor is so expensive has of course to do with our tax system	Investments and subsidies, problem National
3:57	that virgin material is so cheap, of course has to do with the fact that CO2 is not priced just to name a means.	Investments and subsidies, problem National
3:66	then you will also steer towards a different model than just costs.	Investments and subsidies, opportunity National
3:68	So I am somewhat aware of the effort it will take to introduce a CO2 tax, because we as the Netherlands will never do it on our own, so that has to be European again, so slowly.	EU Investments and subsidies, problem
4:2	And then yes, the largest cost items for us are often fuel, we are dealing with fuel prices. Of course you have to take that into account more and more these days.	Investments and subsidies, problem National
4:3	Well, we always have new equipment. So we always try to renew in a timely manner, so you just have your general costs and depreciation of things.	Investments and subsidies, problem National
4:4	Because at some point there was a period when recycling became so cheap and man-hours became so expensive. And then the reuse was often no longer worth it	Investments and subsidies, problem National
4:9	We are now working on the SBIR project, which is from Rijkswaterstaat, where we are doing it together with Royal Haskoning, SGS Search, Dura Vermeer and Haltsma.	Investments and subsidies, opportunity National
4:10	But yes, if you already see what such an investigation in advance already costs. Then you can say, yes, am also going to do this with a hollow-core slab in a 40-year-old building?	Investments and subsidies, problem National
4:13	until now it has often been considered yes, what does it cost to disassemble that beforehand? Because now everything is of course still seen in terms of costs and not in terms of what it actually costs in terms of CO2 emissions and things like that. Now, of course, we always look, what does it cost? What does a new beam cost? And what will it cost if we dismantle that beam?	Investments and subsidies, problem National

4:15	what we're running into is really now the cost.	Investments and subsidies, problem National
4:17	But yes, then of course the municipality has already looked at it in advance and specifications have been issued with which we are going to reuse those beams. Make a price that you can reuse those beams.	Investments and subsidies, opportunity National
4:28	if you have it in the financial sense, then you have to deal with what a client asks.	Investments and subsidies, opportunity National
4:29	Does he say we want to sell this all circularly, or at least you get the construction specifications here. We have received a report. We want this percentage to be reused. But not with ourselves. We want it to be sold on the market.	Investments and subsidies, opportunity National
4:30	You have parties that say, we have made a valuation of the materials that are in it. And those are often kitchens and things like that, to which you can simply assign a certain value. Then they say, we want you to give this as a discount, or we want you to give it a value, yourself.	Investments and subsidies, opportunity National
4:31	and sometimes they give a little more time, so they don't necessarily say I get more money or you have to give a certain discount, but it takes us a very long time so that we have as many opportunities as possible that all materials that you agree in advance, that they are all reused	Investments and subsidies, opportunity National
4:32	if it takes longer, it will of course cost more.	Investments and subsidies, problem National
4:33	So it just depends on what the function of the client is. If it comes from the municipality, yes, they do have an exemplary function, so they can't say, yes, we are going to completely demolish an entire town hall and that will be thrown into a heap and it will be disposed of in no time. So yes, they must also have their story ready of, yes, this is reused and we reuse this in our own building and this is sold on the market.	Investments and subsidies, opportunity National
4:34	they have to drill cores, that has to go to a laboratory, then they will investigate. Well, then the researcher says in advance that it costs so much and that is, so to speak, half of the entire project	Investments and subsidies, problem National
4:35	But yes, you should see it this way if you have of course tested a beam, then those other, say 20 beams that are in the viaduct are all good too.	Investments and subsidies, opportunity National
4:36	So yes, whether that will necessarily be expensive in the future, I don't know, but now, because you're doing things for the first time, it just costs a lot more money, considerably more money.	Investments and subsidies, problem National
4:38	this is a pilot from Rijkswaterstaat. I think there are 5 parties doing it. I think there are 5 SBIR projects, or at least we have already completed the SBIR project. We are now working on a new one.	Investments and subsidies, opportunity National
4:39	Yes. Those are just pilot projects.	Investments and subsidies, opportunity National
4:41	What kind of machines do you need for that? What should we invest in in the future? Are we going to invest in a hammer or are we going to invest in some kind of brush that can sand off the top layer?	Investments and subsidies, opportunity Local
4:42	Well, you can submit a tender more competitively. The stronger the network actually is, so the more customers you have with recycled materials, the more competitive you can submit a tender	Investments and subsidies, opportunity National
4:43	So if a steel bridge has to be demolished in Germany or something, we do it with the machines we have. That is not necessarily because something has to be reused, but because we have the machines for it.	EU Investments and subsidies, opportunity
5:2	at a certain point a lot of materials come in and then at a certain point you just start looking for: where can I create more sales market?	Financial due diligence, opportunity Local
5:3	And yes, then at some point of course the ball started rolling and then you look like yes, what else can you do?	Financial due diligence, opportunity Local
5:8	that just takes a lot of time, effort and money	Investments and subsidies, problem National
5:9	if we think we have something we can use, yes, we invest in it, in order to eventually sell it on the market.	Investments and subsidies, opportunity Local
5:20	That requires time and investment and all that sort of thing and we are not afraid of that.	Investments and subsidies, problem National
5:25	Of course that means: that costs money.	Investments and subsidies, problem National
5:26	And then of course you hope that at some point or another there will be a subsidy scheme somewhere that you can possibly join, so that you can say: well, I can get part of those research costs subsidized	Investments and subsidies, opportunity National
5:27	And luckily there are some subsidy pots for that, because of course the government also stimulates it, so that makes it a bit more attractive in that respect	Investments and subsidies, opportunity National
5:28	Of course, it still costs money at the bottom.	Investments and subsidies, problem National
5:29	Well I do know one of WBSO	Investments and subsidies, opportunity National
5:30	if the government wants something and you don't subsidize anything, then people drop out anyway, because yes, people do want to invest, but yes, a certain part must of course be financed.	Financial due diligence, problem National
5:31	You can of course say on a small scale, yes, it can be done, but if you can't scale it up, or things like that, then you have to ask yourself whether that is still viable now.	Investments and subsidies, opportunity Local
5:32	that if the demolition process is very time-consuming and labour-intensive and therefore requires a lot of money, then at a certain point the question is: will it pay for itself at the bottom,	Investments and subsidies, problem National
5:33	if there are potential opportunities that a new object has to be built somewhere, placed somewhere, a new building or that sort of thing, then it is of course useful if you can sit down at the table from a government agency rather than there.	Investments and subsidies, opportunity National
5:34	if you are known within the municipality and province as a demolisher and builder and producer of circular materials, and therefore supply an innovative product such as concrete without cement, where the performances are all good, then it is a small step that if a viaduct needs to be replaced, which then the civil service says, we have good connections with WP-B, let's talk to that. What's possible?	Investments and subsidies, opportunity National
6:1	this is an innovation that is, as it were, purchased by Rijkswaterstaat. In fact, they enable us to create a circular viaduct.	Investments and subsidies, opportunity National
6:5	We are now in the phase where we also want to scale up and that we do not want to get stuck in the pilot stage, but also want to use it commercially, and that is a very big challenge.	Investments and subsidies, problem Local
6:26	The price of a new beam plays an important role. So how much does a new beam cost?	Global Investments and subsidies, problem
6:27	We actually said, at this stage, when we arrive with a second hand beam, with a reusable beam, it shouldn't actually be more expensive than a new beam. Because if you are a customer and you have been given a circular aim, or a sustainability aim, then it becomes a bit more difficult if that means that you have to spend more money.	Financial due diligence, opportunity National

6:28	The price of a new beam is quite low, it is increasing a bit, because raw materials are becoming more expensive,	Global Investments and subsidies, problem
6:29	especially if a CO2 tax is levied, then that price will go up. This makes it easier to reuse old beams.	Investments and subsidies, opportunity National
6:47	So of course projects need a budget and it's always hard to defend now that you're going to go over budget, just financially, for a second-hand material.	Financial due diligence, problem National
6:49	in the end, of course, we have to make a margin. So we're looking at the conditions under which we can make that margin.	Financial due diligence, opportunity Local
6:50	So we also want to invest, if there is reasonable certainty that we can earn back those investments.	Investments and subsidies, opportunity Local
6:51	And we are now empowered by that SBIR assignment to prove that it is possible.	Investments and subsidies, opportunity National
6:52	As a result, we manage to run that pilot.	Investments and subsidies, opportunity National
6:53	Rijkswaterstaat will not continue to encourage this with extra funds and we will not pay for it ourselves, so we have to look for opportunities in that combination of costs and revenues and MKI profit in order to be able to make a little margin.	Financial due diligence, problem Local
6:54	Because to take beams from somewhere, transport them somewhere, then put them here in a storage yard, that costs money. They also cost money in the storage area.	Investments and subsidies, problem National
6:57	because that pilot will come together. Now it's about scaling up.	Investments and subsidies, problem Local
6:60	We cannot take that step yet, because we do not know what the market looks like and Rijkswaterstaat does not know that, other clients do not know that	Investments and subsidies, problem National
6:63	but we are not going to set up a company for it now, because it is now too uncertain.	Investments and subsidies, problem National
6:67	We are excited to put energy into this. But we won't invest a lot of money if we don't know whether it will pay off in the end.	Investments and subsidies, problem National
7:8	Yes, and then new companies just pop up like mushrooms. So you have New Horizon which I just mentioned that, you may be familiar with that. Of course the best-known example of this, but also, for example, a Dura Vermeer and also a Bam who are now busy setting up so-called Urban Miners. Also a bit of the terminology they now use, huh? So it's not reusing, but it's really mining and harvesting, which is also often used in that context. So you can see that there are really significant innovations going on, both with new companies such as New Horizon and with existing construction companies that are going to set up those projects themselves	Investments and subsidies, opportunity National
7:14	also because they now see, especially for example a Dura Vermeer, which is a bit ahead of the whole thing, that it can also really yield a profit. So that you no longer have to create completely new concrete and that you can simply reuse that concrete that you already have in older demolition buildings	Financial due diligence, opportunity Local
7:18	What you see is that financing can sometimes be difficult. It still costs money to do it now. It is not yet developed to the point where it makes money	Investments and subsidies, problem National
7:19	what you see now is that construction companies, because they know that we have to take steps, that they sometimes invest money themselves	Investments and subsidies, opportunity Local
7:20	I spoke to a builder who did that on a contract. They simply said themselves, we actually want to start working with circular concrete, also to teach ourselves a bit about how it should be done and how it works.	Investments and subsidies, opportunity Local
7:22	Nevertheless, they have decided to put money into it so that they can gain that experience and really start working with it.	Investments and subsidies, opportunity Local
7:25	And yes, the reality is now that circularity is not yet the cheapest. It probably will be, but it just isn't right now.	Investments and subsidies, problem National
7:26	And if you ever want to make it cheaper, it's better to start as early as possible and then make that investment now and then have it paid out in the long run.	Investments and subsidies, opportunity Local
7:28	Yes, and in the long run it will of course become profitable if it runs and so an urban miner runs and everyone is handy.	Investments and subsidies, opportunity Local
7:29	And what we as IG-A also hope will happen is that not every company will set up its own island again and start working with its own urban miner, but that that urban miner will also be used a bit like New Horizon for all construction companies and that anyone can sign up and use them. Yes, and then you just make that efficiency improvement that you need to make it really profitable.	Investments and subsidies, opportunity National
7:31	the efficiency improvement that the companies themselves are making to make circular construction so cheap that it will eventually become cheaper than supplying new materials.	Investments and subsidies, opportunity Local
7:32	You have those urban mines that more and more companies can use, and also each other's urban mines.	Investments and subsidies, opportunity National
7:37	Yes, that also happens. There is certainly a business model behind it.	Financial due diligence, opportunity Local
7:38	New Horizon, for example, started out as an independent company, but has since been taken over by the Janssen De Jong Group, one of the largest construction companies in the Netherlands. For the rest, this is not publicized or anything like that, because they also say, in principle we are there for everyone and Jansen Jong has now taken us over. So we are owned by a specific construction company, but they continue to work for anyone who wants and wants to sign up.	Financial due diligence, opportunity National
7:39	that is a business model in itself and you often see that within construction companies	Financial due diligence, opportunity National
7:40	I think that at Dura Vermeer they do that because part of their equipment is actually not from Dura itself, but from a subsidiary of Dura and the parent company then hires that from the subsidiary. But there it is also possible that the subsidiary also rents it out to external parties, so a bit that sharing economy principle, which is already happening to a certain extent in the construction industry. Yes, that will happen with this one too.	Financial due diligence, opportunity National
7:41	the opportunities are of course plentiful and with rising material costs,	Global Investments and subsidies, problem
7:42	and it will be cheaper in the long run	Global Investments and subsidies, opportunity
7:46	it also helps, the whole price increase due to the war in Ukraine. You can see that for steel, for example, it is already much more attractive to reuse it from existing buildings than to have new steel pressed. Just because it just got really expensive.	Global Investments and subsidies, opportunity

8:5	This is a machine that we now have operational on a large scale in Zaandam.	Investments and subsidies, opportunity Local
8:18	That is of course about the value you add and you must of course be able to capitalize on that value. I can say: these are very valuable raw materials, but if no one wants to buy them from me, then it is of no use to me. So that's part: are we able to recover the added value of this process?	Financial due diligence, opportunity National
8:19	the costs that I have to incur to get this done, not only in the demolition process, but of course also in the investment in the technology, are they manageable, so that you end up with a business case?	Investments and subsidies, opportunity National
8:20	On the cost side: the smart liberator consumes substantially less energy than a traditional crusher. So when it comes to the costs of operating such an installation, they are in any case lower than the linear variant.	Investments and subsidies, opportunity National
8:21	but what you get out of it are pure raw materials and you can pay them against the normal raw material value.	Financial due diligence, opportunity National
8:22	If it is a comparable product, it makes sense that you would get the same price. So for gravel that's for sure, and for sand too.	Financial due diligence, opportunity National
8:23	For cement you can have the discussion whether I shouldn't get more for it. Because we are gradually also pricing in CO2 emissions in construction.	Financial due diligence, opportunity National
8:27	And so you may even be able to charge a little more for it.	Financial due diligence, opportunity National
8:29	Now we actually just deliver for nothing more than usual. We deliver at a normal price.	Financial due diligence, opportunity National
8:30	We have raised it slightly, but many of our clients can get that tax back.	Investments and subsidies, opportunity National
8:31	Our concrete is on the MIA/VAMIL list, which means that if you are going to make a commercial building, an office or something else commercial, you can deduct that early. That means that you get 7 euros back from that extra investment. So we are only a little bit more expensive.	Investments and subsidies, opportunity National
8:32	It will be even different if that client brings in donor buildings.	Investments and subsidies, opportunity National
8:33	Everyone wants them to meet the standard, but if no one up front donates me donor buildings, then I can't keep this device running. So I just need raw materials.	Investments and subsidies, problem National
8:34	So to many questions about building materials that we receive, our answer is also, at least before we quote a price for the delivery: "what can you contribute?".	Investments and subsidies, opportunity National
8:35	Because if you can contribute something, then I don't have to take it off the market, but then I get it from you, yes, then of course I make a direct loop. That does not mean that your concrete will literally be returned to your work, but that does mean that on balance it will become a material balance in which I run much less risk, so that I do not need that surplus of revenue either.	National Risk evaluation, opportunity
8:36	So what I'm looking for is simply: give me the demolition work that you might put on the market elsewhere in the Netherlands. Then give it to me, I'll do it for no more than usual, so I don't ask for more money for the dismantling, but the fact that I then get control over the raw materials means that I can make the loop. That's actually what we're trying to do. So I am structurally looking for donor buildings.	Investments and subsidies, opportunity National
8:37	but I can at least try to make that sector realize that the demand for a circular building material in any case produces a question in return: what do you contribute, in this model?	Investments and subsidies, opportunity National
8:57	I would in any case, I think many entrepreneurs will say that, adjust the tax laws, but I would adjust it by restoring the balance, namely taxing labor less and taxing the use of primary raw materials more heavily.	Investments and subsidies, problem National
8:58	I think it's bizarre that if we have something like VAT, the abbreviation means value added tax, I find a raw material that we reuse, which is just reused one on one, so we no longer have any added value, because we had already given it, then that VAT has to be removed.	Financial due diligence, problem National
8:59	Then I understand that there must be VAT on the hours that I put into it, I think that's right, but that product has remained that product.	Financial due diligence, problem National
8:60	And actually I can only do something with housing associations and care. I could say there, with housing corporations: that wood that I scrap from you, that remains on paper, I make new products from it, then you don't have to pay VAT on the raw material component of the new product. But I can't do this in other sectors.	Financial due diligence, opportunity National
8:61	The rest will simply reclaim VAT, so they have no interest in playing this game. Housing associations and healthcare do,	Financial due diligence, problem National