Brownfield office development in a circular urban economy

A master's thesis

DOCUMENT

Type	**Research Report**
Education	**Master Spatial Planning**
Specialisation	**Land, Planning & Real Estate**
Institution	**Radboud University Nijmegen**
Faculty	**Nijmegen School of Management**
Date	**07-2023**

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Abstract

The work environment is changing; the pandemic made the employee reinvent working from home. Now, hybrid working has become the new norm where employees like to alternate between days at the office and at home. This trend has effects on the office demand; people now perceive the office as a place to meet colleagues, to brainstorm, to think creatively and to socialize. The overall office attendance has dropped so downscaling is necessary to limit costs. These developments have made office spaces in the inner-city more popular and could be a potential solution for the current retail vacancy. However, transforming these Brownfield plots into new offices asks for some comprehensive planning and construction processes. This research proposal will introduce the concept of inner-city Brownfield redevelopment and the way it can facilitate the emerging demand for inner-city office spaces. The concept of the circular economy will also be connected to this planning development to integrate it into the sustainable demands of the current and future urban society. Theory and the conceptual model, suggest that circularity and Brownfield development projects are holistic planning processes in which the concepts of systems thinking are applied. Several challenges mentioned in the theory showcase that it is a complex operation but is worthwhile considering the revitalization and liveability of the inner-city.

The method explains how this research will use several cases as objects of study to construct a theory from real world situations to eventually answer the following research question:

> *How are circular practices being implemented in the construction and operationalization phase of projects that turn inner-city Brownfields to modern offices in the Netherlands?*

The cases have illustrated how a circular Brownfield office transformation has been executed in construction/ renovation and operationalization. Some of the main learning points emerging from the detailed case studies are that circularity can be considered as an integral part of a more holistic approach in designing a modern office environment. Aspects like sustainability, energy efficiency, inclusiveness, creativity, innovation, and collaboration are also important factors to consider. Designing an office that meets the needs of its end-user: the employee and branding a unique building identity that merges with the local community and its surroundings are factors that make these developments so successful.

Keywords

Brownfields, circularity, sustainability, inner-city, construction and operationalisation phase, offices.

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Circular Economy (CE)

RoyalHaskoning DHV (RHDHV)

1.0 Introduction

The circularity ambitions are set: The Netherlands wants to have a fully circular economy by 2050, meaning that the concept of waste must be discarded, and the usage of sustainable and renewable raw materials should be improved so that products and materials are reused as much as possible (Rijksoverheid, 2016). Part of the strategy towards this goal, is the aim to already use 50% fewer primary raw materials by 2030. The construction sector can make a major contribution to this as their footprint on material use is immense. Keeping materials circulating for as long as possible is the new approach. The transition from a linear to a circular economy will be one of the most challenging tasks of the 21st century (Rijksoverheid, 2016).

On the other hand, the Covid pandemic has also been a profound event in this century. For many, this has left a lasting, possibly damaging, impression. The global economy, the ways people meet, and social issues have changed drastically. This also applies to the office sector and the way people work. A 40-hour week at the office is becoming more uncommon, because people experienced the convenience of working from home. But even after two years in isolation, where Microsoft Teams became a digital evil because the need for human contact was urgent, office occupation has not returned to pre-Covid times (Ginneken, 2023). Employee needs have changed; alternation between office and home days is the new norm. Offices must therefore become a place where colleagues can be together. The workplace becomes a social place and so should the environment around the office be. A colossal business park on the outskirts of the city is making way for the lively city centre. This trend influences spatial planning and the way in which offices will blend into the streetscape in the future (Ginneken, 2023).

These large sites on the outskirts of the city are also called 'greenfield locations'. But greenfield development is replaced by Brownfield development, which happens on a smaller scale, in already built-up areas, where existing buildings or plots are given a new destination, to efficiently use as much unused space in the city as possible (MinistryofHousing, 2021). Urban regeneration/renewal has gained momentum among academics, policymakers, and authorities as an effective approach to ensure long-term urban sustainability (Sessa, Russo, & Sica, 2022).

Brownfield development fits within the line of thought of the Circular Economy (CE) because old buildings are reused and given a new purpose. But how is this operationalized in the construction of office spaces? What is being done to ensure the circularity of the process of transforming these offices to new creative working environments?

The Brownfield movement comes at a right time because the demand for inner city office space is pressing just like the need for more nature and less urbanization. Why expand and use up nature while there is enough space and opportunity within the existing city?

1.1 Problem statement

Retail vacancy has rapidly increased in the last ten years. With the rise of online shopping and the fall of 'fun shopping', small entrepreneurs are being outcompeted from the city centre, which is further accelerated by the COVID pandemic (Maas, 2020). This caused retail vacancy to rise to more than 40% in 2022 (PBL, 2022). In 2021, the total vacancy number in the Netherlands was 219.000 units (CBS, 2021), not considering stalled sites and unused plots. While it creates a problem of deserted shopping streets, it also poses opportunities for inner-city transformation.

As for office vacancy, because working from home became the new norm and many saw the convenience of this. Even after the pandemic, office occupancy has not returned to pre-COVID times. Employees like to alternate between working from home and office days, which has led to a much lower overall office occupancy. Companies decide to move to offices with a lower capacity to reduce costs (PBL, 2022). Moreover, the large business parks on the outskirts of the city are no longer desirable. A new trend is underway where offices are transforming from a workplace to a social place. This changed trend brings with it a new demand where Brownfields in the city centre are suddenly very popular. Redevelopments of these inner-city Brownfields will therefore occur frequently in the coming years.

Furthermore, building land in the Netherlands is scarce and the land that is available is also needed for other urgent matters, such as the expansion of wind- and solar fields or the development of forests (Kok & Eichholtz, 2021), which is an essential task because NL scores as one of the lowest in Europe in terms of nature connectedness and biodiversity (Barkham, 2022). And from all countries with a population above 10 million, the Netherlands globally ranks second in urbanization percentages relative to land surface (UN, 2021). Further expanding cities and their surface area would therefore not seem like a sustainable decision. This is in line with the policy framework of the Green Deal, which aims to make the EU climate neutral in 2050 (Sessa, Russo, & Sica, 2022).

But the construction sector is not sustainable or circular, only 8% of all building material is reused in the construction of new houses or commercial real estate (Allessie, 2022). Although there is a lot of recycling in the Netherlands, the recycled construction waste, consisting mainly of crushed concrete, is only usable for roads. This is considered low level reuse, which means that circular opportunities are not available (Allessie, 2022). Demolition is often preferred over reuse because it saves labour costs and time.

However, there is hope for the market for the reuse of materials. The shortage of building materials caused the price to increase. Reusing or renovating is therefore becoming more interesting especially with the current office relocation assignment in mind (Holtrust, 2015).

Adding to this is institutional incentive for inner-city Brownfield development through national and EU policy. Several European strategies such as the Green Deal stimulate sustainable urban development and regeneration in which Brownfield development plays a vital role (Sessa et al, 2022). National policy regarding nitrogen also hampers new urban construction outside the city which indirectly leads to infill redevelopment and building renovation of Brownfields to be a viable 'plan b' (Rijkswaterstaat, 2018).

At last, land acquisition for Brownfield plots is more expensive than greenfield development. The scale on which a Brownfield development takes place is also much smaller, resulting in less profit and therefore less interesting for private developers to invest. Moreover, adopting circular practices such as reusing, redesigning, and repairing old buildings to transform them into modern office spaces is a time-consuming process (Allessie, 2022).

All in all, inner-city Brownfield development will be a hot topic the coming years with the rising demand of small-scale office spaces, lack of building space, and the urge to change to a circular, more sustainable economic model. How this will turn out spatially is dependent on how authorities react now and how well the concepts of CE fit within Brownfield redevelopment. Spatial planners should always consider current demands of the market and its end-user to implement societal needs into spatial design.

1.2 Research aim and research question(s)

This study tries to provide additional knowledge in the construction and operationalization phase of projects that turn inner-city Brownfield sites into modern office spaces by a circular approach. This will be done by studying several Brownfield cases from the consultancy agency RoyalHaskoning DHV (RHDHV). Eventually a set of recommendations are aimed to result from this study that can be applied in the planning process of circular Brownfield office redevelopment in the Netherlands. From this aim, several questions arise which serve as a red wire through this research with the following question as focus point:

> *How are circular practices being implemented in the construction and operationalization phase of projects that turn inner-city Brownfields to modern offices in The Netherlands?*

The following sub questions serve as a build up to eventually answer the previous question:

- How is the relevant national and European policy framework affecting the circular redevelopment of inner-city Brownfield sites?
- How are the projects where RHDHV offices are relocated to inner-city Brownfield sites operationalized in terms of construction and renovation?
- How are the projects where RHDHV offices are relocated to inner-city Brownfield sites currently operating and maintaining circular and sustainable standards?
- Which lessons in circularity can be taken away from the case projects?

1.3 Scientific and societal relevance of the research

Societal

Circularity challenges the current economic model towards a sustainable future (Cramer, 2020). This is relevant for current and future generations to continue living in a thriving community. Redevelopment of Brownfield sites is considered an essential part in achieving a sustainable urban society and is therefore enshrined in several key urban policy frameworks (Pediaditi, et. al, 2005). Inner-city Brownfield sites furthermore present an opportunity to complement the demand for inner-city office space in a post-COVID society. It regards companies that want to keep their working environment up to date with current trends and needs of their employees and want to have their contribution to the CE through their working environment. Adding knowledge in this field of study will also contribute to several other societal challenges that can be mitigated by circular Brownfield development such as inner-city vacancy, mitigating city expansion and thus further urbanization, and providing a solution for the earlier mentioned building land scarcity (Barkham, 2022). Adding

theoretical knowledge in a practical sector like this could also provide a starting point for a transition to a more circular construction sector (Allessie, 2022). Strengthening the theoretical foundation in this research domain could also mitigate several complexities which this sector is currently facing which could make it a better alternative for the competing greenfield alternative (Henderson & Raco, 2006). At last, this research complies with the Dutch and European institutional incentive to transform the built environment to a circular economic model. (Sessa et al, 2022) Research in this field of study is therefore of societal and economic relevance and crucial for a sustainable urban future and planning process.

Scientific

The development and construction sector are the fields which put the most pressure on the natural environment and its role in transitioning to a CE is therefore essential. This research aims to address the research gap regarding the application of CE principles to inner-city Brownfield redevelopment in the office market context. While there is existing literature on brownfield redevelopment and the CE, less attention has been drawn to the specific challenges and opportunities of applying CE strategies in Brownfield office transformation (Rosemary D. F. Bromley, 2005). Furthermore, looking at construction research from a CE perspective has shown a lack of focus on the buildings as a unique entity (Pomponi & Moncaster, 2017). Moreover, a lack in interdisciplinary research appeared related to the scale of analysis. Many examples also exist where redevelopment of Brownfield sites has not been sustainable, as it did not assess the environmental, social, economic, and physical impacts holistically in relation to CE standards and practices, as well as to consider the long-term impacts of Brownfield redevelopment projects (Pediaditi, et. al, 2005). Operationalization of circular Brownfield development into modern inner-city offices is also a relatively new trend and therefore underexposed in today's literature. Comprehending the scientific relevance of this study is pivotal as it can have both theoretical and practical implications. The findings of academic work can contribute to the academic discourse by improving knowledge on the convergence of inner-city Brownfield redevelopment, CE principles, sustainability, and modern office creation. Moreover, the practical outcomes of this research can inform and inspire policymakers, urban planners, office users, investors, and developers about the potential of circular Brownfield redevelopment as a sustainable and integrated approach to comply with the new inner-city office demand (Weimert, & Zweck, 2022).

2.0 Theoretical framework

The theoretical framework will provide the necessary theory to give the research a well-defined basis of argument.

2.1 Literature review

2.1.1 Concept of circularity in the construction sector

The circular economy is a successor to the linear economy and is an economic system of closed cycles in which raw materials, components and products lose their value as little as possible, renewable energy sources are used and system thinking is central. Initially, the CE was centred around the 3Rs: reduce, reuse, recycle. However, in recent years there has been a new development that is more nuanced. 3Rs became 10Rs (see Figure 1) in which recycling is no longer considered a positive level of circularity (Cramer, 2020). Circularity in the built environment can be perceived on the macro level: e.g., cities, meso level: e.g., buildings (most relevant for this research), and micro level: e.g., manufacturing of components. A building is circular if stocks are kept in a closed cycle during construction and management, without harmful emissions to the air, water, and soil. The materials used for construction must have been reused in previous construction works, or be biobased materials that grow back relatively quickly, with wood as the main example. The extraction of raw materials must in any case be prevented as much as possible in circular construction. According to Stahel & MacArthur 2019, there is plenty of potential in the construction industry as one third of all material resources are used in the construction industry, and only 8% of the materials is currently reused in the construction of houses (Stahel & MacArthur, 2019).

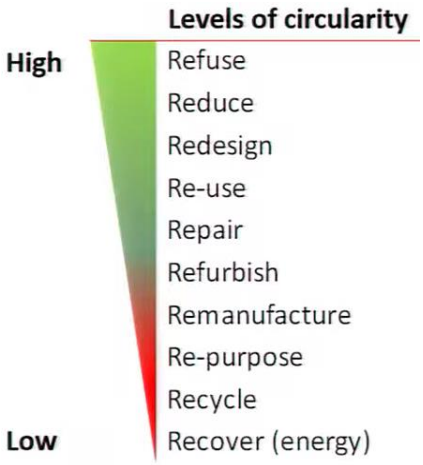

Figure 1: 10R's of Circularity (Cramer, 2020).

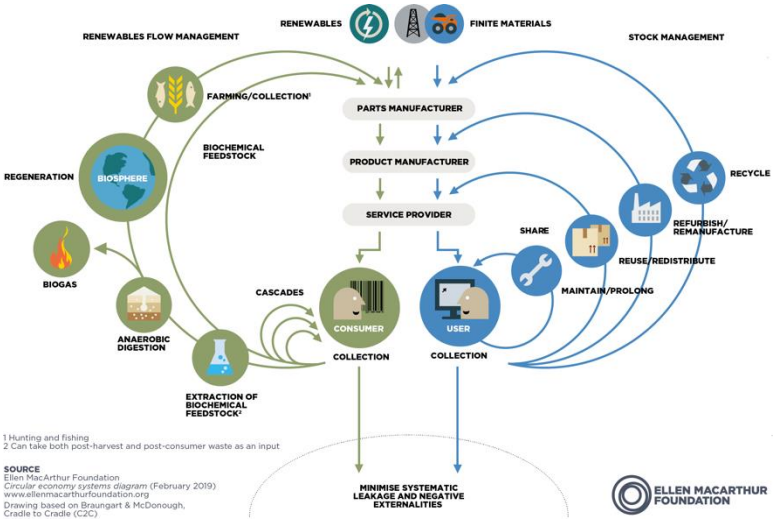

Figure 2: Visualising the circular economy: the butterfly diagram (Stahel & MacArthur, 2019).

Urban mining – material reuse

A concept within the building sector that is focused on limiting extraction from natural resources is urban mining, which is anything between re-use and recycling of valuable raw materials from waste derived from the construction and demolition industry. This way of dismantling buildings ensures that materials from the building can be reused as much as possible and can serve new products (Xavier & Giese, 2021). For example, concrete that is released during demolition can be used to make new concrete, with a major reduction in CO2 emissions. An additional advantage of urban mining is that it makes very rare earth metals such as europium and terbium available again. Quite a few of these critical materials are almost exclusively extracted in China in small amounts (Xavier & Giese, 2021). Urban mining as a concept can help urban areas limit resource use, pollution and waste that otherwise ends up in landfills. This will stimulate the transition process towards sustainable urban areas, which will promote the development of many new extractive and processing industries (Arora et. al , 2020).

Material Circularity Indicator

A way to express the circularity of a building in percentages is done by using the Material Circularity Indicator (MCI), which is an indicator that measures the circularity of a product or a building. It is a calculation method developed by the Ellen MacArthur Foundation and covers the entire life cycle of a product starting from raw material extraction, through processing and assembly, to use and the end-of-life phase (Stahel & MacArthur, 2019). It measures circularity based on tonnages of material (mass) when it is based on a closed cycle circular process. Reuse and recycling are included in the calculation, however, no distinction is made between high-quality vs. low-grade recycling (downcycling). There is also no distinction between renewable (bio-based) and technical materials. It is an important tool to objectively assess the circularity of a certain object (Stahel & MacArthur, 2019). See figure 3 for the formula and explanation:

$$MCI = 1 - \frac{\text{Primary raw materials} + \text{waste}}{2 * \text{Mass}} * \frac{0{,}9}{TL / FL}$$

TL= technical lifespan FL= Functional lifespan

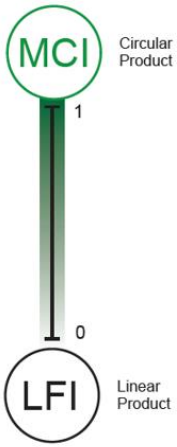

Figure 3: MCI formula, retrieved from (Stahel & MacArthur, 2019).

2.1.2 Brownfield development terminology

Brownfield sites are defined by the ECCC as: *"abandoned, idle or underutilized commercial or industrial properties in built-up areas or private residential gardens, parks, recreation grounds and allotments; that were previously developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time but still have great redevelopment potential"* (ECCC, 2021 p. 1). Reusing Brownfield areas is seen as a strategy that can have "broader economic, environmental and social benefits" for urban centres. More generally, urban Brownfield development contributes to compact, sustainable cities. Positive effects of Brownfield redevelopment, such as averting the development of overcrowded zones, creating additional employment opportunities within the city limits, reducing urban sprawl and greenfield development, and enabling a *"more compact and energy-efficient urban lifestyle, lead to the conclusion that, at least in theory, the conversion of such sites presents a "win-win" opportunity for all stakeholders involved"* (Henderson & Raco, 2006 p. 1).

One aspect of Brownfield development makes it fit well within the CE: ''brings derelict areas back into use''. This circular way of developing re-uses existing structures and gives it new purposes. Re-using is also considered a high level of circularity according the 10R's of Cramer (Cramer, 2020).

2.1.3 Brownfield development complications

Inner-city Brownfield areas are spatially complex. They are often located in densely populated areas, with little room for expansion. Practical considerations such as *"misallocation, legacy of excess infrastructure, remediation costs, high rehabilitation costs and reduced real estate value" pose serious problems for involved parties when redeveloping Brownfield land''* (Henderson & Raco, 2006 p.12). Whether there is a sufficient connection to infrastructure has important physical and legal consequences as well. A variety of other factors can also influence Brownfield land redevelopment in the inner-city, like inconvenient lot forms, ownership structures, dividing public/private sector interests, and a variety of physical obstacles. Ownership insecurities and the existence of the previous mentioned challenges could hinder the redevelopment of Brownfield sites, which is rarely the case with greenfield locations (Thornton, 2007).

2.1.4 Optimalisation of the built environment

Following the previous chapter, compared to Greenfields, Brownfields are in many ways less attractive for local authorities and developers. Why even consider building in the existing borders of the city then? Well, there are several reasons why a sprawling city design is far from ideal and sustainable with the future urban environment in mind. A compact city fits better in the CE concept and has many benefits compared to a sprawling city. According to a 2018 report from The New Climate Economy (NCE) *"Compact cities produce fewer emissions because they tend to offer better access to public transit and cycling and walking paths, have greater energy efficiency, have lower environmental costs for infrastructure, and allow for more green spaces."* (NCE, 2018 p 2.). The report furthermore states that making cities more compact could lead to global economic savings of up to $17 trillion by 2050. Catlyne Haddaoui from the World Resource Institute states that: *''Infrastructure is less costly to build and maintain in compact cities. Residents don't have to travel that far or deal with congestion and air pollution which boosts the GDP. Furthermore, compact cities bring people closer together, stimulate innovation and increase productivity.''* (Haddaoui, 2009 p 1.) These benefits greatly enhance an area's sustainability and efficiency.

Furthermore, according to Sessa et al. 2022, the greatest potential for sustainable urban development comes from the recovery and rehabilitation of the existing building stock, referred to as Brownfield land redevelopment, within the borders of the city. The European Green Deal is seen as an opportunity to create a low-carbon transition and a long-term strategy for urban regeneration through inner-city brownfield land redevelopment (Sessa, Russo, & Sica, 2022 p. 3).

Paris proof buildings

A label that is currently used in the Netherlands to address a sustainable future proof building is the ''Paris Proof'' designation. A ''Paris Proof'' built environment cannot use more energy than is sustainably generated in the Netherlands. This means that, looking at 2013 as reference year, by 2050 it is only possible to generate 1/3 of the that energy consumption of buildings sustainably, according to research by Royal Haskoning (RHDHV, 2019). This means that the built environment currently uses three times more energy than allowed according to 2050 standards. The 'current' energy consumption of the existing buildings must therefore be reduced by 2/3 to stay within this energy budget. A new maximum energy consumption per square meter per year was then defined for each building type (Tuinenga, 2022).

From 2040, an existing 'Paris Proof' office building has a maximum energy usage of 70 kWh per m2 per year. The bar is higher for a new-build office: the starting point is that the current new building will be TENB (Truly Energy-Neutral Building). A TENB uses 0 kWh/m2 on an annual basis on the meter. So, if a current new construction is not carried out as TENB, the requirements for existing buildings must be tightened in the future to achieve the 'Paris Proof' objective. Meaning that a new building will still have to be adapted by 2050 to meet the requirements. Or that the requirements for existing buildings will be tightened even further (Tuinenga, 2022).

2.1.5 A liveable inner city

As mentioned in the problem statement, Dutch city centres currently experience high vacancy rates especially in the retail sector, which affects the liveability of the area. According to research conducted in Swansea and Bristol by Bromley, RDF et. al, urban redevelopment in the city centre can regenerate the area and increase sustainability. In their research they state that: *''Urban redevelopment can contribute to sustainability through the recycling of derelict land and buildings. This can reduce demand for peripheral development and assist the development of more compact cities.''* (Rosemary D. F. Bromley, 2005 p 12.). The researchers furthermore describe in their paper that inner-city redevelopment substantially reduces the car use and enhances pedestrianization. The research also stresses out the importance of mixed use in the inner-city, aligning with Jane Jacob's theory (Rosemary D. F. Bromley, 2005).

Jane Jacobs affirms the idea of a mixed neighbourhood: "*The most important question about planning cities is this: How can cities generate enough mixture among uses - enough diversity - throughout enough of their territories, to sustain their own civilization?*" (Jacobs, 1961 ch. 9-11). However, according to her, this diversity does not arise automatically. Four preconditions are necessary for this:

1. *''A district/neighbourhood must have several functions, preferably more than two (living, working, shopping, eating, etc.). Different functions bring different purposes, causing a mixed activity pattern which increases the livelihood''* (Jacobs, 1961 ch. 9-11).
2. *''Large building blocks are not preferred. Ensure there are enough bends and side streets so that places are accessible (intersections are a victory for those who think in terms of walkers, but for those who think in terms of cars, a disaster)''* (Jacobs, 1961 ch. 9-11).
3. *''A district must have buildings of different years of construction and condition, so cherish historical sites''* (Jacobs, 1961 ch. 9-11).
4. *''Population density must be high to increase economic efficiency''* (Jacobs, 1961 ch. 9-11).

The four preconditions are closely related and mutually reinforcing; a varied population that uses streets intensively, provides the local businesses with customers and the various commercial enterprises add economic activity. The small businesses add a stabilizing social element to the neighbourhood and old buildings offer cheap rental space that can be used as incubators for new businesses (Brownfields). The fine-meshed street pattern and the short blocks ensure a more equal distribution of the flows of people and make a neighbourhood more accessible for both residents and users. In addition, this versatile traffic flow also ensures social and political interaction, which

contributes to the construction of a diverse, lively neighbourhood (Jacobs, 1961). So, redeveloping inner city Brownfield sites also has social, economic, and communal benefits.

2.1.6 Pandemic influences

Consultancy firm DTNP analysed the inner-city retail abandonment trend, which was sparked by the rise of online shopping and accelerated by the COVID pandemic. The research indicates that in 20 years, 50% of all former inner-city retail buildings are expected to be empty (Frielink, 2021). Figures 4 and 5 illustrate this trend. While this trend is perceived as a negative thing, especially for the ambiance of urban centres, DTNP also emphasizes the opportunities for residential and office development (Frielink, 2021).

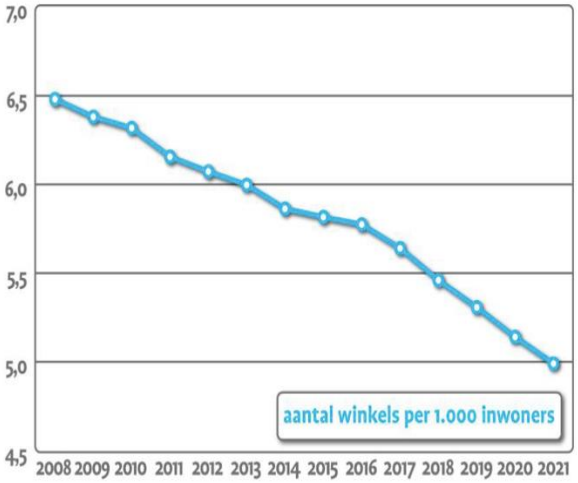

Figure 4: Number of shops per 1000 inhabitants, retrieved from: (Frielink, 2021).

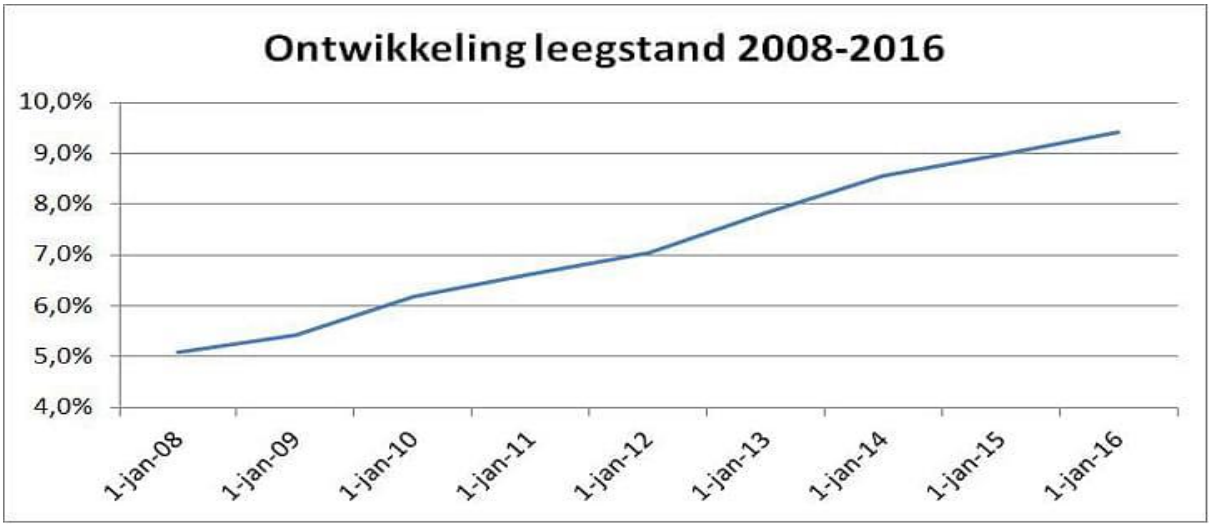

Figure 5: Retail vacancy trend 2008-2016, retrieved from: (Locatus, 2021).

The pandemic sparked another trend where offices are turning into houses, because demand for new office space was low. However, times have changed, because the inner-city has become popular again due to its central location, surrounding amenities, public transport hubs and high-quality office buildings. The employee of today decides when one works at home or at the office as they have been able to get acquainted with hybrid working during COVID. Large offices are therefore no longer needed. More employees are working from home, organizations are getting smaller and office work is now "creative thinking", and creative ideas are born at work. This places new demands on the location: new office should inspire. No sterile meeting rooms, but nice consultation units. Working at

home, relaxing at the office. It must be fun to be in the office, to brainstorm, to meet each other. And sustainability is also an issue; as from this year, office buildings are legally required to have energy label ''C'' at least (Ginneken, 2023).

According to RHDHV, their corporate identity should be reflected in their physical working environment. They try to implement co-creation with employees to acquire information about their specific needs and requirements and implement an innovative and sustainable design in their offices. Their offices should be able to facilitate internal and external cooperation, inspire their employees, stimulate an energetic and fresh environment, and enlarge flexibility. Their offices should function as a place to cooperate with colleagues, facilitate client and partner meetings, stimulate knowledge transfer and cross-pollination between different departments, serve as a meeting place for employees and enhance company pride and team feeling. At last, the surroundings of the office should be sustainable, social, and liveable, and minimize commuting time for employees (close to mobility hubs). (RHDHV, 2020).

A way to systematically measure employees' experience, is ''the Leesman Index'' (LMI), a functionality and effectiveness score for a workplace environment. It is calculated for every company and measures it through a set of data collected via a questionnaire, designed to give insight into how a workplace is affecting employee performance and happiness. The Leesman Index is the world's largest insight database on employee workplace experience (Ferris, 2019).

2.1.7 Brownfield policy

European Union Policies

Despite the benefits, economic viability is often an insecurity, which means that policy incentive is still necessary to realize Brownfield development. According to a study conducted by the University of Illinois, there is a strong system of policy and funding frameworks that work synergistically to support redevelopment of Brownfields across the EU. By including Brownfield-remediation in the EU's sustainability goals, many countries have preserved green spaces while meeting the needs of private and public companies through the creation of spaces that are fully integrated into the socioeconomic and cultural landscapes (EuropeanCommission, 2019) (Morar C, 2021). The European Green Deal policy also encourages member countries to move to a more careful allocation of resources through investments in urban brownfield land renewal projects (Sessa, Russo, & Sica, 2022).

Although Brownfield redevelopment is often funded by local sources or private investment, the EU also has a complex framework of funding to support regional projects. The primary funding

mechanisms are the Cohesion Fund and the European Regional Development Fund (ERDF). There are also supplementary funding mechanisms that support sustainable development and environmental restoration projects (Morar C, 2021).

Policies	
European Union 2030 Agenda for Sustainable Development and Sustainable Development Goals.	*''It supports Brownfields redevelopment by making cities and human settlements inclusive, safe, resilient, and sustainable; protecting, restoring, and promoting sustainable use of terrestrial ecosystems; and halting and reversing land degradation''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
7th Environment Action Programme.	*''The policy focuses on conservation of natural resources and the environment, reduction of environmental health risk, and establishment of sustainable cities—which can promote Brownfields redevelopments as opportunities for sustainable redevelopment''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
European Environmental Directives: Waste, Water, and Air Quality Legislation.	*''Coupled with broader policy initiatives, the existing environmental directives can support clean-up and redevelopment of Brownfields and can address water and air contamination associated with these sites such as from plume migration, runoff, and air emissions"* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
Urban Agenda for the European Union.	*''Themes of this policy relevant to Brownfields redevelopment are the sustainable use of land; sound and strategic urban planning; limiting greenfield consumption; and urban regeneration, including social, economic, environmental, spatial, and cultural aspects"* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
Soil Thematic Strategy.	*''The strategy promotes minimizing additional land acquisition and limiting, mitigating, or compensating soil sealing, calling for efficient use and restoration of previously acquired land, which can prevent development of green areas and aligns with the reuse of already built abandoned areas (i.e., Brownfields* (EuropeanCommission, 2019)*")* (Morar C, 2021 p. 1).
European Union Biodiversity Strategy for 2030.	*''The strategy can promote healthy and sustainable communities through Brownfields reuse focused on protecting and creating green space, restoring watersheds, reducing the urban heat island effect, protecting the night sky and wildlife, and turning blighted and abandoned spaces into community assets''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
Green Infrastructure Strategy.	*''This strategy promotes cost-effective alternatives to traditional "grey" infrastructure (the built environment) and offers many other benefits to EU residents and to biodiversity. Turning grey infrastructure into green infrastructure through Brownfields reuse is a natural solution to local planning problems. Green infrastructure can avoid building new infrastructure by a) reusing sites such as Brownfields and b) incorporating natural spaces to provide less expensive and more sustainable solutions''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).

Information is retrieved from (EuropeanCommission, 2019) and (Morar C, 2021 p. 1).

Funding frameworks	
Cohesion Fund	*''This policy outlines growth and development through clustering (i.e., actions focused on competitiveness), internal urban cohesion (i.e., redeveloping Brownfield sites, preserving, and developing the cultural heritage), or promotion of a more balanced, polycentric development (i.e., creating networking opportunities for urban areas and linking the physical infrastructure with communities)''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
European Regional Development Fund	*''Through this fund cities can receive finance for "taking action to improve the urban environment, to revitalise cities, regenerate, and decontaminate Brownfield sites (including conversion areas)"* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
Urban Innovative Actions	*''This funding makes direct financial contributions to support innovative approaches to sustainable land use and land use planning (i.e., remediation, restoration, and prevention of Brownfields). The UIA indirectly contributes to sustainability through inclusive urban regeneration and sustainable urban development projects"* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
URBACT III 2014–2020	*''This fund helps European cities to develop new, sustainable, and pragmatic solutions that integrate economic, social, and environmental factors. It focuses on the intersection of the urban physical economy with themes of environment, governance, inclusion, and economy''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
LIFE Programme	*''This programme supports projects in the environmental sector, particularly in the areas of air, chemicals, green and circular economy, waste, water, soil, and the urban environment. Funded projects will implement technologies and solutions that are ready for implementation in close-to-market conditions, at industrial or commercial scale, and during the project period"* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
European Investment Bank	*''The EIB provides funding for sustainable public–private investment, research, and innovation projects in line with EU environmental objectives. EIB provides an infrastructure for large investments (e.g., Brownfields redevelopment) focused on remediation of contaminated urban and industrial sites and renovation of housing and high energy-efficiency buildings''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
URBIS	*''URBIS is an urban investment advisory platform that assists urban authorities to facilitate, accelerate, and unlock urban investment projects, programs, and platforms, which also include Brownfield redevelopment projects''* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).
Horizon 2020	*''The program focuses on supporting excellent science and industrial leadership and tackling societal challenges in innovative ways"* (EuropeanCommission, 2019) (Morar C, 2021 p. 1).

Information is retrieved from (EuropeanCommission, 2019) and (Morar C, 2021 p. 1).

Dutch Policies

On September 11, 2020, the Dutch government adopted the National Environmental Vision ("NOVI"). The NOVI has been developed in collaboration with local authorities, social institutions and citizens and contains a long-term perspective for the development of the physical living environment in the Netherlands up to 2050. The NOVI gives direction to various important tasks regarding the living environment. One of these tasks concerns making the economy and energy supply sustainable and strengthening the quality of the living environment. An article from Ploum about logistic centres stated that, in general, the state and provincial governments have a strong preference for integrating logistics centres at Brownfield locations, if there is a demonstrable need for this (Ploum, 2022).

Regarding Brownfield locations in inner cities, policy in the Netherlands is often determined by municipal authorities. There is an increasing incentive from politicians to hinder large greenfield locations to save rural and natural areas. However, there are no regulations for this at a national level yet, although Rijkswaterstaat published a report which explains how Brownfield development could be stimulated (Rijkswaterstaat, 2018). Furthermore, there is a new law expected to be introduced next year that is applicable to the entire living environment (Omgevingswet). This law can therefore facilitate Brownfield development as well.

2.2 Relevant theoretical frameworks

These frameworks illustrate how circular Brownfield redevelopment is conceptualized into theory.

2.2.1 Framework for circular economy research in the built environment

This framework provides a systematic approach in researching the different dimensions in studies concerning the CE in the built environment. It highlights research in facilitating the transition to 'circular buildings' and considers the current discourse on sustainability of the built environment. As such it can provide a valuable starting point for research in CE in the built environment and to shaping future research initiatives (Pomponi & Moncaster, 2017, p. 4).

Building research

From a systemic point of view, ''buildings'' and the CE differ in terms of scale. Buildings are researched on the meso-level, while the CE is a concept that operates on the macro-level. Researching the CE is therefore more advanced and comprehensive. (Figure 6) (Pomponi & Moncaster, 2017 p.7):

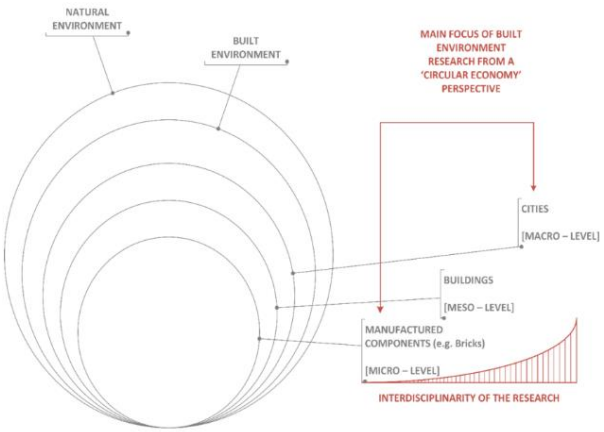

Figure 6: Building research levels (Pomponi & Moncaster, 2017)

Current framing of CE

This step is important to assess which definitions of the CE are currently active and how it affects research. A common frame of the CE is shown in figure 7. Although a broader view of CE also entails political, societal, technical, governmental, environmental, economic, and social dimensions (Pomponi & Moncaster, 2017 p.9).

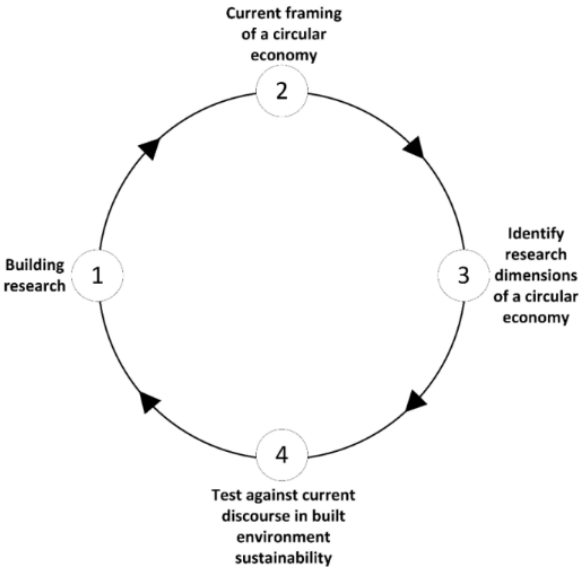

Figure 7: Framing of CE cycle (Pomponi & Moncaster, 2017)

Current research dimensions of CE

In finding out the research dimensions, at least three more defining elements are missing which are: the role of governments (i.e., policy), the role of matter (e.g., design, technology, materials), and the role of individuals (i.e., behavioral) (figure 8). All of these are pivotal for the success of a global system such as CE (Pomponi & Moncaster, 2017 p.12).

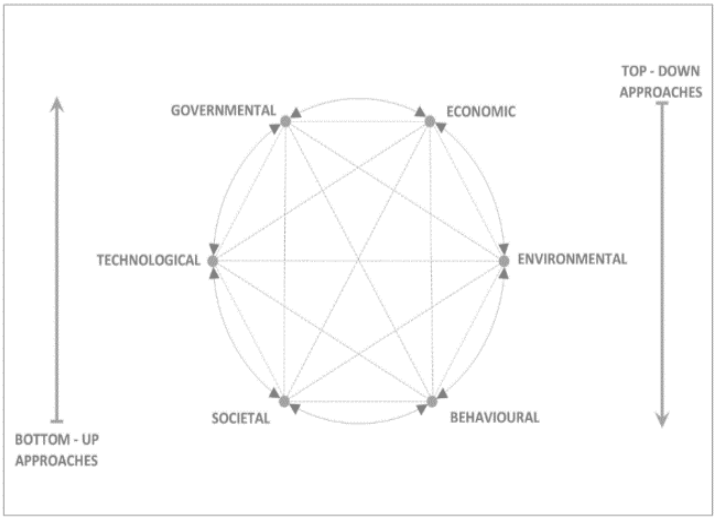

Figure 8: CE research dimensions (Pomponi & Moncaster, 2017)

Test against current discourse in built environment sustainability

Each of the dimensions discussed above are also subject to the currently active discourse about CE and sustainability in the built environment. The discourse is determined by societal and cultural trends at that time and can differ per country or region. Discourse is over time not considered as a constant concept over time, but something that is subject to change and variation (Pomponi & Moncaster, 2017).

2.2.2 Framework for Brownfield redevelopment: the project lifecycle

This framework illustrates the life cycle of a Brownfield project. The planning and design phase is crucial in determining the sustainability of the project because in this phase, the site gets recyded, stakeholders are engaged, and decisions are made that affect the development throughout the rest of the cycle. The remediation phase is a necessary part in Brownfield projects because they often require an initial site investigation, especially if they turn out to be contaminated. In the construction phase, circular and sustainable principles are put into practice. During this phase, the choices for material use and construction processes are being executed. The final phase considers impacts regarding usage, management operations and long-term maintenance. This involves aspects such as energy efficiency, waste management, and water conservation which would ensure the sustainability of the project on the long-term (Pediaditi, et, al, 2005).

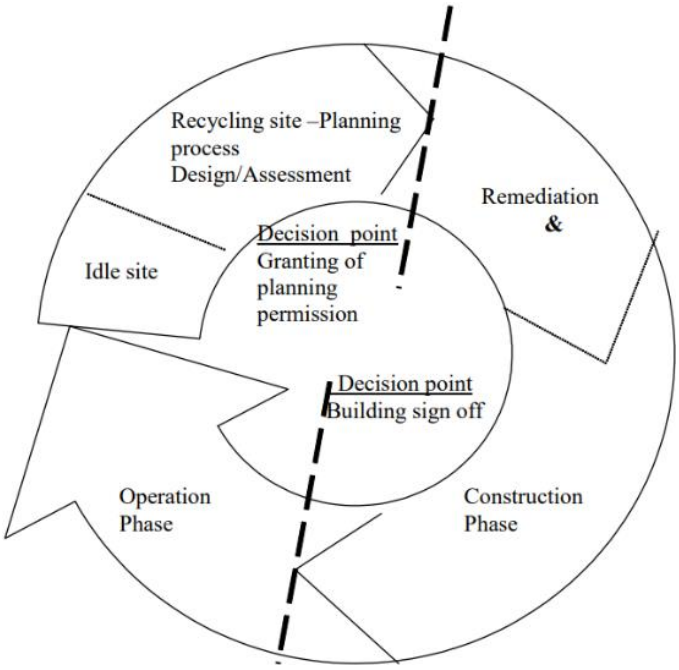

Figure 9: Brownfield project cycle (Pediaditi, et, al, 2005).

2.2.3 Framework for assessing the sustainability of Brownfield redevelopment projects

This framework can be used to assess the sustainability and circularity of a Brownfield redevelopment project using several indicators. The framework consists of two parts: A) Assessment of involved stakeholders in the development and use of Brownfield sites, and B) Assessment of sustainability objectives to be met in Brownfield developments (Williams & Dair, 2007).

Stakeholder assessment
Group 1. Regulators, statutory consultees, service providers and councilors
Group 2. Non-statutory consultees, interest groups, and individuals
Group 3. Property developers and developer interests
Group 4. Professional advisors
Group 5. End users

(Williams & Dair, 2007, p. 26)

Sustainability assessment	
Economic sustainability objectives (Williams & Dair, 2007, p. 30)	
1. Enabling businesses to be efficient and competitive	*''Reduce energy consumption in construction.''* *''Reduce waste in construction.''* *''Minimize energy and water consumption''.* *''Provide developments with renewable energy power sources''.* *''Provide high quality urban design, including secure premises''.* *''Provide high quality buildings that are flexible and can be adapted with minimum costs''.* *''Provide transport infrastructure to meet business needs''.*
2. Promote local economic diversity	*''Provide higher densities to enhance commercial viability''.* *''Provide a mix of uses to increase viability and vitality of commercial areas''.* *''Enable a supply of properly serviced land and business premises''.* *''Use locally produced goods and materials in construction''.*
3. Support employment opportunities	*''Provide a mix of uses to give choice of employment''.* *''Develop high quality buildings for manufacturing and commercial activities''.* *''Increase the recruitment of local unemployed people''.* *''Provide a mix of uses to give choice of employment''.*
Social sustainability objectives (Williams & Dair, 2007, p. 30)	
1. Ethical standards during the development process	*''Ensure ethical trading throughout the supply chain of a development''.* *''Provide a safe and healthy work environment''.* *''Comply with labor conventions (non-discrimination/reasonable hours)''.*
2. Provide adequate local services and facilities to serve the development	*''Provide space for training''.* *''Provide open space for community benefit''.* *''Develop good quality energy efficient buildings for community activities''.* *''Offer a mix of retail spaces''.*
3. Provide hosing to meet local needs.	*''Develop a mix of housing tenure and type''.* *''Provide affordable housing''.*

	''Provide high quality and flexible buildings that minimize the use of resources''.
4. To integrate the development within the locality	*''Provide multiple links to adjacent neighborhoods''.* *''Reject or discourage gated developments''.* *''Create a mix of transport provision with a variety of modal links to services, work, leisure, and homes''.* *''Provide good access for people with disabilities.''*
5. To conserve local culture and heritage, if appropriate	*''Reuse locally valued buildings.''* *''Design developments to reflect local heritage and use local materials.''*
Environmental sustainability objectives (Williams & Dair, 2007, p. 31)	
1. To minimize the use of resources	*''Use renewable materials, e.g., sustainably produced timber. Use recycled materials, e.g., aggregates. ''* *''Use renewable energy sources, e.g., wind turbines, photovoltaic cells. Design developments for minimum waste during construction, life, and after-life. ''* *''Use materials with low energy inputs.''*
2. To minimise pollution	*''Remediate contaminated land."* *''Reduce air pollution including dust during construction.''* *''Mitigate noise pollution both during and after construction.''* *''Provide infrastructure for public transport, walking, cycling.''* *''Raise densities on sites within 800 m of existing centres, services, and transport corridors.''* *''Design buildings for minimum energy consumption in use.''*
3. To protect biodiversity and the natural environment	*''Conserve flora, wildlife, and habitats on site.''* *''Provide wildlife refuges, such as ponds and wild areas. ''* *''Use sustainable urban drainage systems to protect rivers and water courses from pollution and flooding.''*

2.3 Operationalisation of the theory

The conceptual model is visual operationalisation of the previously discussed literature and theories. It illustrates how the concepts discussed earlier are interconnected in an all-encompassing model.

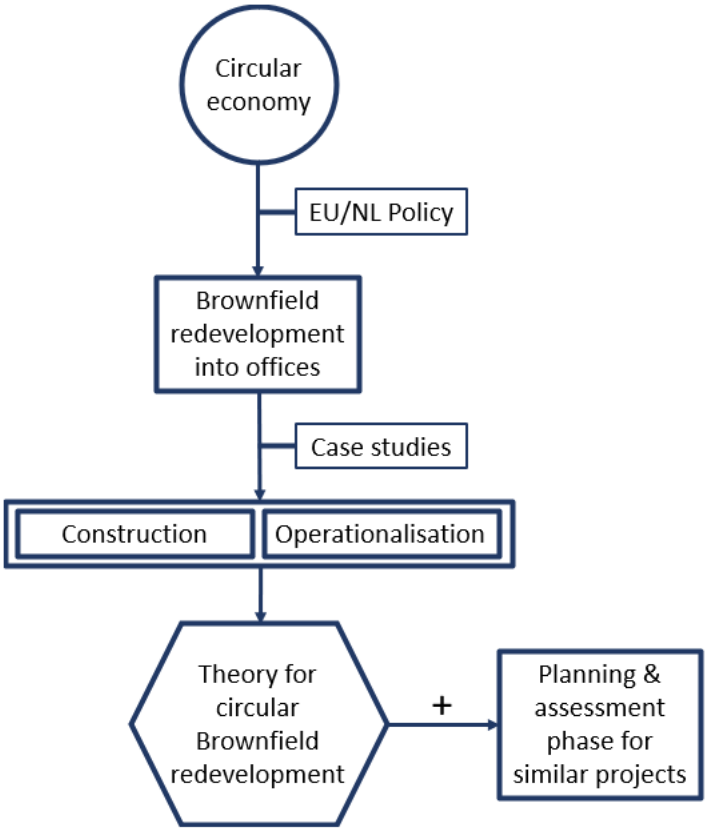

Figure 10: Conceptual model

It all starts with the concept of the CE; from this reasoning this research is initiated. Implementing aspects of the CE in the built environment is a vital step in realising a circular society. In combination with institutional incentives through the mentioned policy frameworks, the activity 'Brownfield redevelopment into offices' arises. From this development two phases are relevant for this research: construction & operationalisation, as it is in these phases that the most impact in terms of circularity can be achieved. This will be examined through a multiple case study approach that will be explained in the methodology. Eventually, from the results of this study, a theory will arise that can be applied in the planning and assessment phase of similar projects for circular Brownfield development.

3.0 Methodology

In this section, the choices for the research methods will be explained and justified in a philosophical context.

3.1 Research strategy

The subject investigated in this study is a recent phenomenon and therefore scarcely brought to light in literature and theory. Therefore, this research adopts an inductive and explorative approach. The literature and theory created a basis from which an empirical case study can be performed. Ultimately, these cases will be analysed and compared, which will lead to an answer to the research question.

3.1 Research methods in philosophical context

In the literature of Van Thiel (2014), case study is described as a research method that fits within research that is of an inductive and exploratory nature and is often applied in studies that have a direct link with the phenomena in practice (van Thiel, 2014). This makes a case study suitable for this research since the subject is a recent socio-economic trend that manifests itself in the inner-city street scene. The philosophical context of Harrison et. al (2017) on case studies complements this reasoning with a pragmatic constructivist view that focuses on perception and interpretation of reality (Harrison et. al, 2017). This research paradigm is suitable for research that explains societal phenomena factually and stresses the importance of the subjective human creation of meaning but does not ignore the notion of objectivity (Guba & Lincoln, 1994). In this approach, close collaboration between the researcher and the participant is possible so they can describe their views of reality, to let the researcher understand their actions (Baxter & Jack, 2010).

The research method in this study is a multiple explanatory case study that sought to explain the presumed causal relation between the current societal trend and the real-life cases. The produced explanations will link spatial program implementation with program effects (Yin, 2003). The choice for multiple cases has been chosen to be able to conduct a comparative analysis to find similarities, differences, and possible trends in relation to the societal phenomena (Baxter & Jack, 2010).

3.2 Data collection

The data from the cases will be collected through corporate data bases, real-life observations, and expert interviews to get a holistic view of the current situation. The experts have been selected on their affinity with the relevant cases. The sources of information are firstly from literature and theoretical studies and secondly from a multiple explanatory case study. The cases that will be researched are:

- RHDHV-office Delft (construction phase)
- RHDHV-office Amsterdam (operationalisation phase)
- RHDHV-office Groningen (operationalisation phase)

The first three cases are selected because two of them are in the operationalisation phase of the project cycle introduced in figure 9 and the Delft case because it is still an ongoing construction. Assessing these phases will give a holistic view of how a Brownfield office project is executed in practice, which can help the last case of the Nijmegen office in their planning process. The cases are in the Netherlands, making the results relevant for Dutch situations or areas with similar planning systems and urban qualities.

3.3 Data analysis

The data retrieved from the literature, theories, interviews, and case studies will be compared to find differences and similarities within the cases and to see if it corresponds with the theories. The data from the case studies that is retrieved through interviews will be transcribed and analysed using Atlas.ti, where information can be grouped and coded to ensure the assessment is structured and transparent. Triangulation is achieved through reviewing the literature and the use of multiple case sources to retrieve information (Moon, 2019)– which could then be validated in interviews and corporate documents related to the current developments (van Thiel, 2014).

3.4 Validity and reliability of the research

3.4.1 Construct validity

Construct validity is secured in this research by doing multiple case studies that provide a comprehensive input of data from which evidence can be subtracted to support the interpretation of how these cases reflect in relation to the theory. To ensure the validity and credibility, the case studies will provide enough in-depth information and detail, so a justified conclusion can be drawn (Moon, 2019). The transparent and systematic way of analysing the data also adds to the credibility of the

study (Yin, 2003). The versatility of the selected cases enables the researcher to find indicators that construct a concept theory that can be used to answer the research question (Baxter & Jack, 2010).

3.4.2 External validity

External validity will be more complicated to ensure in this study as three cases are not sufficient to construct a theory that will be applicable outside the scope of this research. The generalizability is therefore not considered credible in this research. However, according to van Thiel (2014): *"the findings of a single case study will be valid only for the case in question, yet often findings can be regarded as representative for other situations in the same research domain, even when these have not been actually studied."* (Van Thiel p. 89, 2014). This entails that results from the case studies could be applicable to comparable situations brownfield situations.

3.4.3 Internal validity

Because the cases that will be studied in this research are comparable in nature, although studied in different phases of the process, the internal validity will be low. As van Thiel stated: *"by creating variation in the independent variables […], the causal relationship can be established more directly, and factors influencing success or failure can be identified with greater certainty. Having said all this, in research with contrasting cases, the effects that are measured will be conditioned by the context of the cases studied; internal validity will be high, and external validity will be low"* (van Thiel, 2014 p.90). Because in this study the cases are comparable, this will be the other way around: low internal validity, high external validity.

3.4.4 General reliability

General reliability in this research is secured through multiple aspects. First, there is access to a comprehensive corporate database. Both Yin and Stake recognize the importance of effectively organizing data. *The advantage of using a database to accomplish this task is that raw data are available for independent inspection. Using a database improves the reliability of the case study as it enables the researcher to track and organize data sources including notes, key documents, tabular materials, narratives, photographs, and audio files can be stored in a database for easy retrieval later* (Baxter & Jack p. 12, 2010). Secondly, the triangulation of the data by using expert interviews, corporate databases and available literature/ theory increases the reliability of the analysis and gives robustness to the conclusions of the study. In addition, they enable a diversity of perspectives on the same phenomenon (Moon, 2019). Thirdly, the data analysis will be executed systematically through Atlas.ti, and the process will be shown to ensure transparency. Feedback from the interviewees will

also be provided to ensure the study's reliability. However, this research will not have a quantitative method through statistical analysis which will hamper the reliability.

4.0 Data analysis

In this chapter the data is collected through multiple case studies and expert interviews.

4.1 Case studies

As mentioned in the previous chapter, this part covers the case studies done on several office locations of RHDHV. The locations Amsterdam and Groningen, which are currently in full operation, and the newly developed location of Delft, which is still in the construction phase. Each case will be analysed on how the development was initiated in terms of location choice, how circular principles were considered in construction and operationalization, and how it is currently being operated. Information in these cases is retrieved through personal observations, corporate data, and formal interviews with relevant professionals.

4.2 RHDHV office Amsterdam

The office of RHDHV is in Amsterdam-Sloterdijk, in the north-western part of the city near the harbour. The area has seen a lot of development recently where it is transforming from an industrial area with mainly logistics companies to a thriving hub for creative and innovative corporations. The building in which the office is located is owned by the real-estate manager Contact Amsterdam, which is known for its sustainable and circular approach in real-estate and connecting different end-users to enhance co-creation, cross-pollination, and smart city design. The building used to be an old storage warehouse and car dealer before it was re-purposed into a RHDHV office and location for creative businesses and interdisciplinary individuals (RHDHV, 2019).

The Amsterdam office is the first location of RHDHV that implements their new vision of a creative, sustainable, and collaborative work environment. Their main ambitions for this location were to create a circular and energy neutral building, a healthy working environment and a space that was smart and flexible for the range of people that would use it. They were looking for a balance between comfort, acoustics, daylight, and energy efficiency as well as having space and facilities for staff to exercise, relax and work. Fr. States:

''In the past, an office was merely a place to be highly functional with business focus. In this office, we focused on the end-user: the employee, and designed it according to their needs and preferences.''[1]

[1] Fr 5:32 14-04-2023 (author's translation)

''In this project, our focus was not on financial incentives, but on future values such as circularity and sustainability in a healthy working environment.'' [2]

They encountered challenges in striving for both circularity and energy efficiency at the same time whereas reusing as much of the old structure as possible will give high circularity percentages but will limit energy efficiency as older warehouse buildings have less optimal insulation. El, Fr and Fh State:

''Second -hand materials and buildings conflicts with sustainability and energy objectives.'' [3]

''Are we being responsible with energy consumption? Are we being responsible with employee welfare and health? Such questions arise when deciding on circular material use. Maintaining unhealthy industrial structures for example, is initially circular, but not preferable.'' [4]

''Energy label / sustainability of old buildings such as industrial real estate is often the main motive for demolishing Brownfields instead of transforming them.'' [5]

The real-estate manager Contact Amsterdam facilitated the collaboration between local start-ups and creative individuals by designing shared spaces and workplaces that can be utilized by all users. Examples of individuals located in the same building are film and furniture makers, circular fashion designers, programmers, architects, and painters. Through this variable work environment, creativity and cross-pollination are enhanced, and stimulate a positive work environment and overall user well-being. The MakerSpace, designed by Contact Amsterdam, is an example of such a shared working space. It is equipped with a 3D-rinter, laser cutter, various metal and wood processors and offers a growing spot for office plants.

''Shared/mixed use of space enhances efficiency and circularity; we reuse space and therefore refuse the use of new space'' [6]

Figure 11: MakerSpace in Contact Amsterdam office, retrieved from editor.

[2] Fr. 5:45 14-04-2023 (author's translation)
[3] El. 36:49 12-04-2023 (author's translation)
[4] Fr. 7:09 14-04-2023 (author's translation)
[5] Fh. 21:12 14-04-2023 (author's translation)
[6] El. 6:37 12-04-2023 (author's translation)

4.2.1 Construction

The renovation of the building started in 2017 with the so called ''skin'' of the building. Because one of the goals in this project was circularity, the initial structure of the building remained untouched. Only aesthetical implementations were applied to make the building a representative appearance for the company. Image 12 illustrates the different components of a building with their corresponding lifespan to showcase how a renovation can be approached (Brand, 1994).

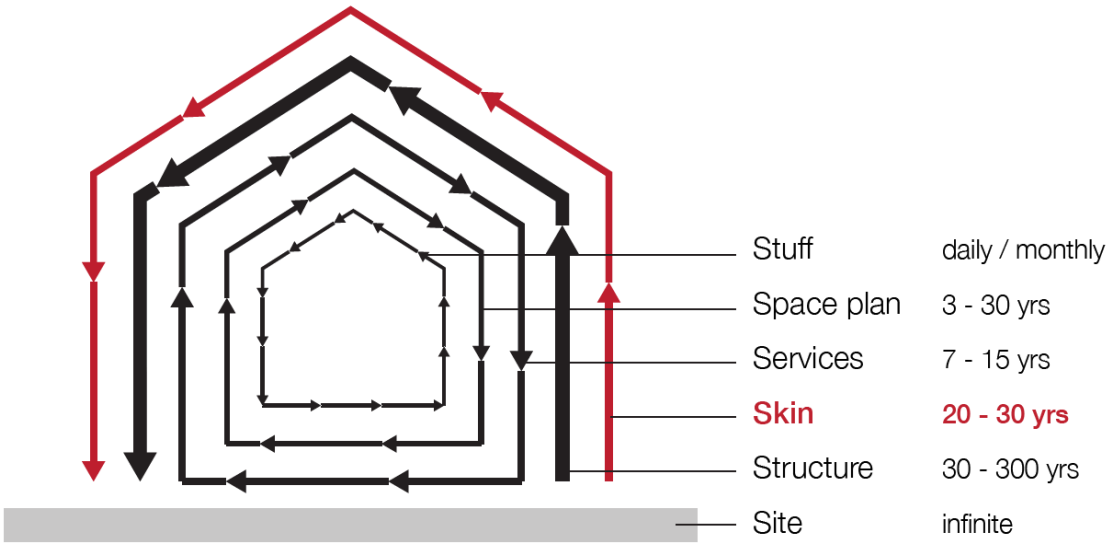

Figure 12: Shearing layers of buildings, retrieved from: (Brand, 1994)

Figure 13: Before and after of the Contact Amsterdam building, retrieved from (RHDHV, 2019).

The skin of the office has been renovated in which only the window frames and the windows itself have been renewed. The applied aluminium frames have a high recycling percentage because they are detachable and therefore easily reusable in the future. According to El.

''We wanted to renew the shell of the building as little as possible because otherwise you would be destroying capital.''[7]

For the total construction process and the renovation of the exterior skin, an MCI calculation has been made according to the formula discussed in chapter 2.1.1.

Construction:

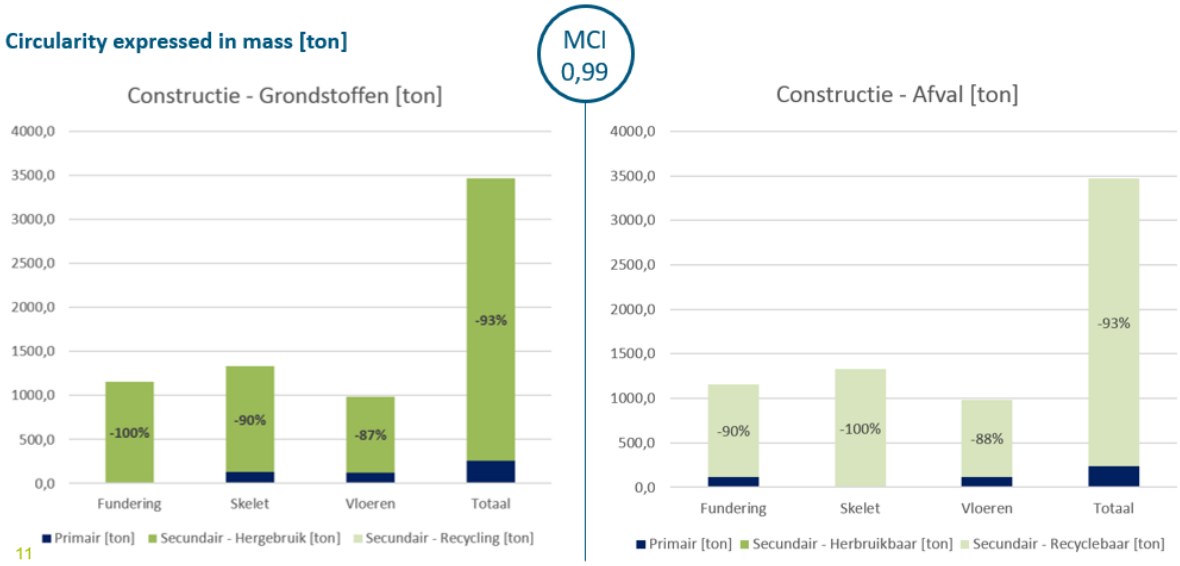

Figure 14: MCI calculation for the construction process, retrieved from (RHDHV, 2019).

The graph illustrates an extremely high MCI percentage mainly due to completely reusing the foundation (100%), almost all the building's skeleton (90%) and the existing floor structure (87%).

According to el. The construction of the building is as expensive as a new project, while most of the theory suggests otherwise; it suggests that challenges such as extra costs in circular Brownfield development are factors that demotivate developers to redevelop and choose to demolish instead.

''The Amsterdam building was no more expensive than a new building, but it was more complex, so what can be saved on materials will have to be invested in finding out best practices and arranging renovation, contact with the building owner, etc.''[8]

[7] El. 16:51 12-04-2023 (author's translation)
[8] El. 31:45 12-04-2023 (author's translation)

Wo and Fh confirm the discourse about Brownfield amongst investors and private developers which contradicts the statement made by El:

''I am in daily contact with investors and developers, and I find it shocking how little incentive they have for sustainable or circular developments, if it is 1€ more expensive to go green, they will not do it.'' [9]

''New construction remains cheaper than Brownfield developments because you can develop faster, so it takes less time.'' [10]

''I only notice that clients from municipalities set certain sustainability requirements.''[11]

''But you also see that these developments take an awfully long time, for example the development of the Albertpark site. These are peripheral issues that make Brownfields less attractive.''[12]

''Logistic side issues of reusing materials make it expensive, such as transport and storage.''[13]

According to El. This issue could be mitigated through laws and building material banks:

''Taking steps to make redevelopments and circular transformations more common will make such projects less complex, so that less investment will have to be made in those peripheral matters, which will make circular developments more profitable. This can be done through such material banks or laws and regulations that stimulate circular transformations such as a mandatory step in the zoning plan that allows developers to make a redevelopment analysis.''[14]

Dt confirms that there are no hard laws or regulations yet in which circularity is a must:

''There is an incentive from the municipality to redevelop in a circular way, but I have never received hard requirements of a minimum percentage.''[15]

An MCI calculation has also been made for the exterior skin:

[9] Wo. 17:31 17-04-2023 (author's translation)
[10] Wo. 16:04 17-04-2023 (author's translation)
[11] Wo. 17:50 17-04-2023 (author's translation)
[12] Fh. 5:09 14-04-2023 (author's translation)
[13] Fh. 42:43 14-04-2023 (author's translation)
[14] El. 32:12 12-04-2023 (author's translation)
[15] Dt. 6:12 11-04-2023 (author's translation)

Exterior skin:

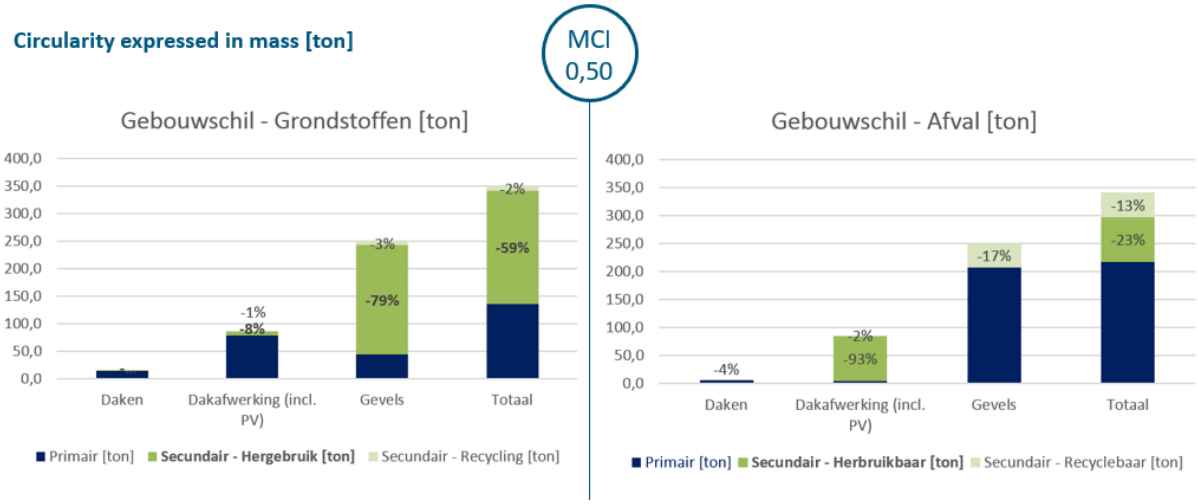

Figure 15: MCI calculation of exterior skin, retrieved from: (RHDHV, 2019).

The MCI for the exterior skin is significantly less (0,50) because the roof is almost completely new and takes up considerable mass of the total structure. Nevertheless, they managed to reuse 79% of the facades.

The interior of the building was also focused on reusing as much of the former structure as possible by keeping initial design of the room intact. The design facilitates multifunctional and flexible use of space and reuses old installations such as second-hand cooling machines and lighting fixtures. Demountable built-in package with recycled wooden partition walls and flexible concentration cells that can be moved during use makes it a hybrid work environment that can be disassembled when necessary, so repurposing and recycling is an easy job (RHDHV, 2019). Er and Fr state:

''OSB plates that are made to install a partition wall come from former desks and can easily be removed again in 5 years.''[16]

''Using nails instead of glue so the meeting boxes are easy to disassemble''[17]

[16] Er. 4:33 01-05-2023 (author's translation)
[17] Fr. 13:16 14-04-2023 (author's translation)

The finishing layers are minimized by only applying it where necessary (e.g., due to acoustic, thermal, or aesthetic requirements). See the before and after in the following picture:

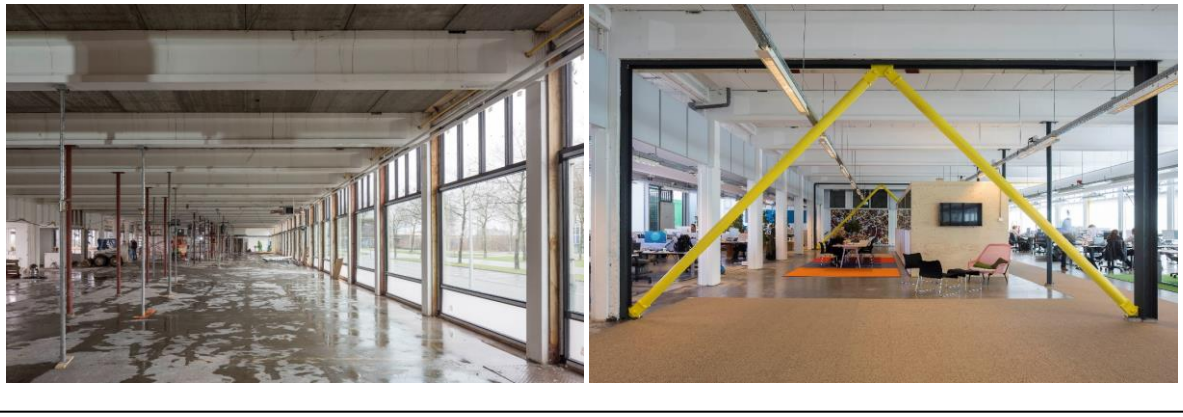

Figure 16: Before and after of the interior of Contact Amsterdam office, retrieved from: (RHDHV, 2019).

Circularity is also ensured in the use of office amenities as for example: BAM containers are reused as meeting rooms; old tabletops are reused as acoustic desk screens with fitting upholstery and office furniture from the previous location is relocated to this location (RHDHV, 2019). See figure on below.

Figure 17: Examples of reused office amenities, retrieved from (RHDHV, 2019).

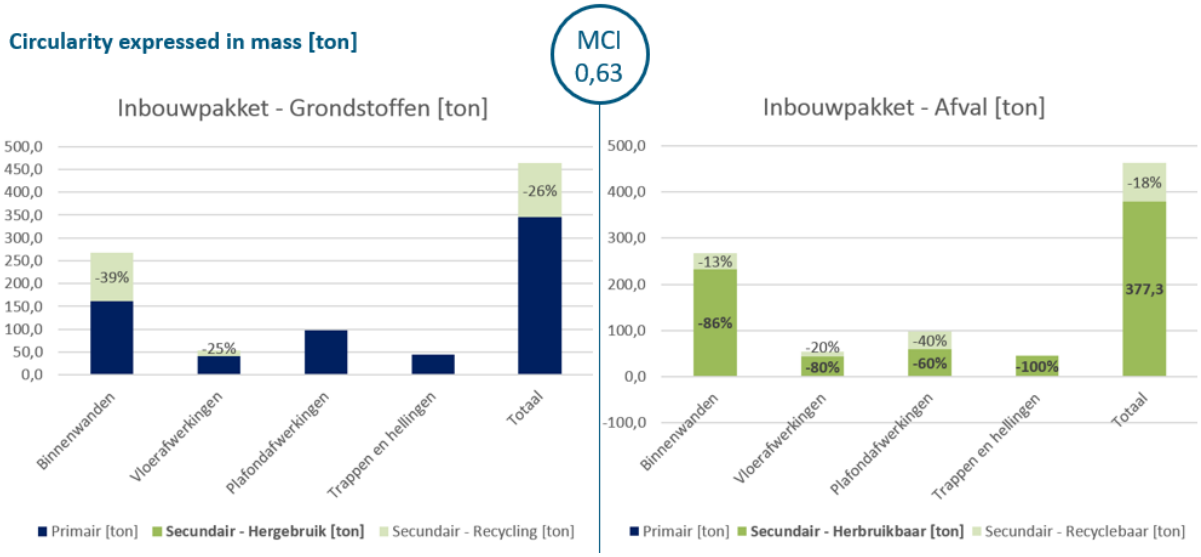

Figure 18: MCI calculation for the total interior, retrieved from: (RHDHV, 2019).

The total circularity value of the interior, including the interior walls, flooring, and ceiling finish and stairs, amounts 63%.

Even during the installations, circularity has been considered. In the mechanical engineering, electrotechnical and transportation processes, an MCI of 0,66 has been acquired (RHDHV, 2019).

For the total building, the circularity index has reached a value of 86% (0,86). What is interesting from this graph is that the construction itself has been reused for 93%. Because the construction itself is most of the mass of the whole building, the MCI index is that high. The built-in package shows a circularity percentage of just 26% because the interior had to be adjusted to make it an office although a lot of materials were given a second life. See following graph for the total calculation.

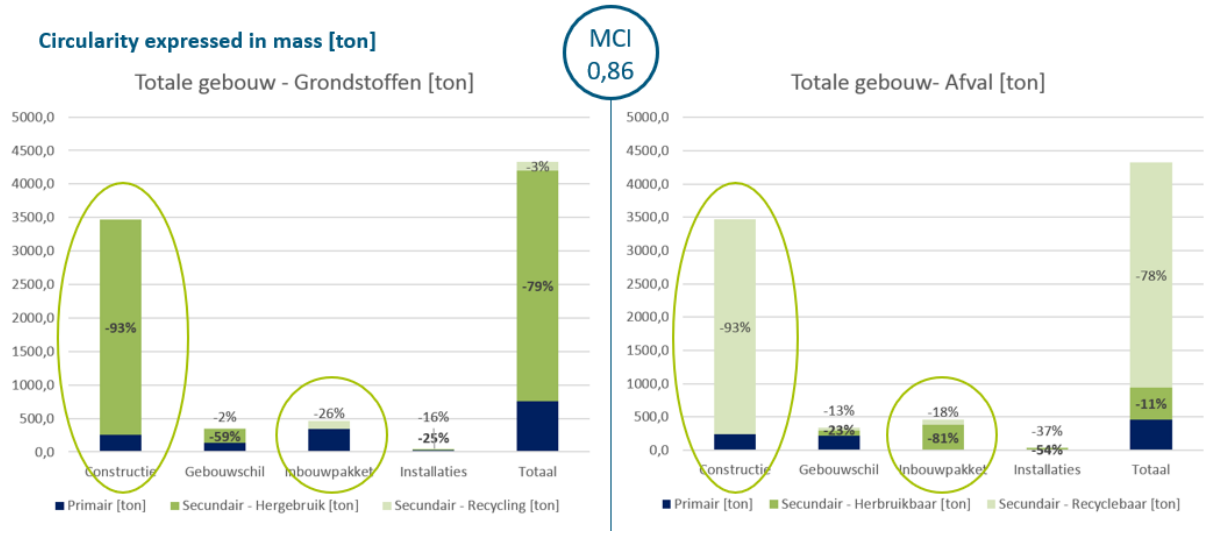

Figure 19: MCI calculation for the total building, retrieved from (RHDHV, 2019).

4.2.2 Operationalization

As seen in the previous part, the building has a Material Circularity Index (MCI) of 0.86% (max. 100%). The RHDHV part of the building (approx. 33%) is energy neutral. The entire building is now 60% energy neutral. The aim is to further improve this in the coming years. There is increased employee satisfaction with the working environment. This is measured by the Leesman Index (LMI), a global workplace experience benchmark (see chapter 2.1.6 for clarification). The working environment is based on the needs of the end users. An optimal setting has been created around this to optimally facilitate these needs. Employee engagement has increased from 23% to almost 70%. This is due to the office design as El and Rs state:

''The office design facilitates chance encounters and cross-pollination with others and start-ups. This is important for the innovative capacity, but also involvement between colleagues and groups.''[18]

''I notice that much more social interaction takes place in the Amsterdam and Groningen offices, which I think is mainly due to the layout and that they are both on the ground floor. I also find the interaction with the other companies interesting.''[19]

However, Wo stresses out the importance of primary office amenities over aesthetics and layout:

''Office charms are less important than primary facilities such as good accessibility and office amenities.''[20]

''Good insulation is also important, especially in the winter. You often notice with old industrial buildings that it is too cold on the walls to work comfortably.''[21]

''In my opinion, the accessibility and overall location of this office is perfect, it is close to the centre of Amsterdam and several public transport connections such as train, tram, metro, and bus are nearby."[22]

''An office close to the centre is very nice. It gives more atmosphere; you can walk around the city with your colleagues during the break and there is always a buzz.''[23]

Acoustics, daylight, and the focus spots, among other things, score higher than the Leesman+ standard. A multifunctional and flexible use of space has been realized. In the evenings and weekends, among other things, the facilities in the ''Broedplaats Contact'' are used by externals. There is a significant increase in the number of customer visits to the office who actively use the co-creation places of the creative Broedplaats. The entire setting increases employee engagement which makes it a social office. This can be considered as one of the success factors in the operationalisation of this office: multiple or circular use of space and proper end-user experience. In the meantime, there have been many events and co-creation sessions with customers, partners and the local stakeholders and

[18] El. 8:43 12-04-2023 (author's translation)
[19] Rs 18:51 07-04-2023 (author's translation)
[20] El. 21:43 12-042023 (author's translation)
[21] Wo. 5:32 17-04-2023 (author's translation)
[22] Wo. 8:15 17-04-2023 (author's translation)
[23] Rs. 20:03 07-04-2023 (author's translation)

community. As El and Fh state, putting effort in a healthy and innovative working environment is crucial for an efficient business operation.

''Effort must be made to make it an inspiring environment, which is often not the motivation that brokers or developers have because they have a financial hat on. The link between the end user with real estate needs and the developer with a profit perspective is not enough. They should be better coordinated.''[24]

''Efforts must be made to give meaning to real estate, especially in circular transformation, then the value increase and return will follow automatically.''[25]

This increases the brand awareness and reputation of the location and increases circular use of the building which is also important according to Fh and Fr.

''Branding plays an important role here; you want your building to radiate a certain identity that your employees can be proud of.''[26]

''When renovating an industrial building or even an entire area, it is about storytelling/branding to preserve the authentic identity. This is crucial to attract workers and even residents.''[27]

What makes this case unique is the fact that RHDHV is end-user and developer at once, which makes them responsible for the user's value as well and not only the real estate acquisition. Therefore, the operationalisation in this case is still sustainable and financially viable. As El and Wo state:

''There is a gap between real estate value and use value, if a developer is also responsible for operationalization, he will opt for more sustainable materials that last longer. If a developer is solely responsible for delivery of materials, they will be as cheap as possible which might hamper the sustainability.''[28]

''Most developers choose projects from which they can get a good profit on the short term, they lack a long-term vision concerning sustainability and circularity for a building.''[29]

[24] El. 23:47 12-04-2023 (author's translation)
[25] Fh. 1:02:07 14-04-2023 (author's translation)
[26] Fr. 27:59 14-04-2023 (author's translation)
[27] Fh. 31:20 14-04-2023 (author's translation)
[28] El. 34:08 12-04-2023 (author's translation)
[29] Wo. 2:44 17-04-2023 (author's translation)

To stimulate those cooperations: a suggestion could be that such an ownership structure is introduced in zoning plan regulations or the new environmental law to motivate developers with a strong financial incentive as El explained and Tb confirms as well:

''A suggestion could be to add a legal step to the zoning plan procedure that first requires a detailed analysis of reuse potential. So, take a good look at the possibilities for use before demolition takes place. Because this is not common practice, it cost us a lot of time and money to see how we could reuse the building.''[30]

Budget management in this case was also operationalized effectively. As El explained earlier, the construction was as expensive as a new development. The following strategy contributed to cost mitigation: Fr. Explains that business costs are around 500.000 a year from which 100.000 are so called ''frozen costs'' which cannot be influenced. The other 400.000 are optimized and spend as efficiently as possible to ensure sustainability and circularity.

''We were maximizing the other 400,000 by for example also looking at how you can clean the building as efficient as possible. Operationalization of the building as efficiently and sustainably as possible to save money (financial feasibility) and to comply with sustainable and circular standards.''[31]

''By developing our own office, we could arrange a lower monthly rent with the building owner''[32]

Another way how RHDHV operationalized this project successful financially is not choosing an ''A location''. Therefore, the acquisition of the building was cheaper which saves money for transformation and maintenance.

''Our new offices are situated in yet undeveloped areas; this makes it cheaper to acquire and saves money for renovations and transformation. The budget for circular and sustainable initiatives is therefore larger.''[33]

[30] Tb. 24:40 12-04-2023 (author's translation)
[31] Fr. 9:41 14-04-2023 (author's translation)
[32] Fr. 23:32 14-04-2023 (author's translation)
[33] Fr. 21:33 14-04-2023 (author's translation)

4.2.3 Conclusion

Some points could be taken away from this case and the input the interviewees provided. Supply and demand of second-hand materials is still limited because it is challenging to acquire second hand materials from other parties. An organized material bank could provide a reasonably stable supply of second-hand materials, something that could have a significant contribution to the transition to a circular economy. As El, Fh and Fr State:

''There is not a place yet where supply and demand meet, such as a marketplace for second-hand building materials, which can solve supply problems for circular building materials.''[34]

''At the municipal level, there should be a kind of depot where you can deliver or obtain second-hand materials.''[35]

''It is a promising yet challenging ideas, because demand and supply need to follow each other seamlessly''[36]

For this reason, plannability and supply is a major challenge when working with reuse which requires this ''supply-driven design'' to be flexible. Furthermore, a demountable design facilitates circularity in the future. This concept of "promised circularity" oppose opportunities in current and future construction phases. Er states that the demountable materials that still have decent quality will be brought to a material bank organized by the developer BAM:

''We have a material bank, initiated by BAM infra, that takes back used materials from our office. However, we could not acquire second-hand materials ourselves from such a bank.''[37]

Also, opportunities for circularity are not only present in building an office and construction itself, but also in its use and the way employees operate in the building. What also does not contribute is that the construction market is still very transactional targeted. Even when take-back intentions are provided, hard financial agreements are difficult and hamper long sustainable building operationalisation as mentioned in the previous chapter. At last, circularity can conflict with other

[34] El. 13:12 12-04-2023 (author's translation)
[35] Fh. 45:06 14-04-2023 (author's translation)
[36] Fr. 33:20 14-04-2023 (author's translation)
[37] Er. 07:27 01-05-2023 (author's translation)

ambitions, such as energy neutrality and sustainability (for example: second-hand cooling machine have a shorter lifespan and use more electricity).

4.3 RHDHV office Groningen

The RoyalHaskoningDHV office in Groningen is in the building of "De STEK". In 2018, an investor bought the building which was a former Center for Vocational Training in Groningen. A huge building of 6300m2 located on the eastern edge of the centre, where the Eemskanaal and the Winschotendiep come together. A promising location at Euvelgunnerweg 25a with 15,000 m2 of space on the total plot, including a large garden and 107 parking spaces on site (parking on the public road is also possible). There is also room for 97 bicycles, and you will find 20 charging points for electric cars in the parking lot. The office building is easily accessible by car, bicycle, and public transport. The distance to the southern ring road (N7) is only 400 meters. Groningen station is only about 10 minutes by bike and bus line 12 stops in front of the door (Klamer, 2019).

At the time it used to be an impoverished building where the owner was unsure what to do with it, after which they placed it on Funda. After a week on the platform, RHDHV encountered them as being interested to use the building, not only as their own office, but also a promising plan to transform it into a modern, sustainable and 100% gas-free building, a future-proof workplace with all the trimmings, but also with a societal mission: a place where they can work together on the future of the region with other tenants (RHDHV, 2020). Some of the before pictures can be seen below:

Figure 20: Before images of the STEK, retrieved from (RHDHV, 2020).

DE STEK has a total floorspace of 6300 m2 with a diverse range of offices from units with 27m2 for start-ups to 220 m2 offices for small companies. Unique is that everything is on one floor, creating one large office village. RHDHV is the biggest company located in the building as they occupy 1174m2 of the floorspace. The other parts are occupied by start-ups, a catering company, and a school for practice-based education. In addition to offices, you will also find flexible workplaces, meeting rooms, the brasserie: cutlery and a company fitness. There is also an iRoom/theatre and a digital room ideal for seminars, events, and presentations. Tenants will stand shoulder to shoulder and work together

on projects to enhance the society of the northern provinces of the Netherlands. Think of outsourcing projects, hybrid traineeships, sharing knowledge through seminars and making optimal use of each other's network. A similar set-up as the Amsterdam office. See following map of the current division of floor space (RHDHV, 2020):

Figure 21: Floorplan the STEK Groningen, retrieved from: (RHDHV, 2020).

The building is designed to promote collaboration internally and externally. Within the vision of RHDHV, it must offer an inspiring and optimal working environment: new impetus, energetic and fresh. The building must increase flexibility and multiple use of space through leases and the office concept. And it must be cost efficient, especially in terms of energy. Collaborating with colleagues and third parties is promoted by facilitating mixed-use spaces that can also host client and partner meetings. The setup of the office should promote knowledge transfer to other areas of expertise and cross-pollination (just like in Amsterdam). There are also meeting points for employees, such as the cafeteria, which promote group feeling and togetherness. Fr and Fh confirm this strategy:

''What we have done with this building and do with every new office building is to create an attractive working environment so that employees enjoy coming to the office. Otherwise, they might as well stay at home, which is not good for solidarity and effective cooperation. Branding plays an important role here; you want your building to radiate a certain identity that your employees can be proud of.'' [38]

[38] Fr 27:59 14-04-2023 (author's translation)

''When renovating an industrial building or even an entire area, it is about storytelling/branding to preserve the authentic identity. This is crucial to attract workers and even residents.''[39]

Tb and Rs confirm this idea:

''Certainly, in Groningen, but also in Amsterdam, the office is a gathering location, so we are not alone in that building. Small start-ups and companies that have a specific function in sheltered employment who strengthen each other in this learning environment. Also, students who find it a bit more difficult to find work, really find a full-fledged workplace here to gain work experience. That are some of the things that come together in Groningen which makes it extra interesting for us.''[40]

''I notice that much more social interaction takes place in the Amsterdam and Groningen offices, which I think is mainly due to the layout and that they are both on the ground floor. I also find the interaction with the other companies interesting.''[41]

In this project, the building is central as a catalyst for other business processes called an integral approach (see image below).

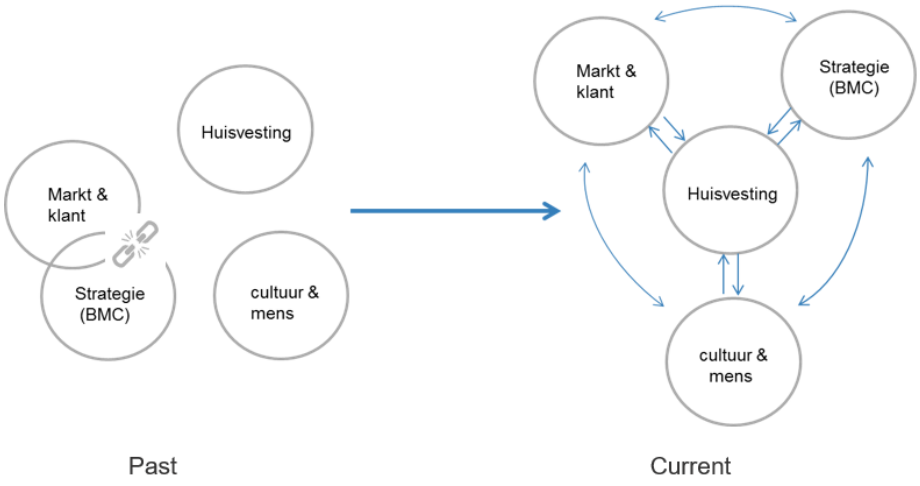

Figure 22: New integral housing approach, retrieved from (RHDHV, 2020).

[39] Fh 31:20 14-04-2023 (author's translation)
[40] Tb 9:51 12-04-2023 (author's translation)
[41] Rs 18:51 07-04-2023 (author's translation)

4.3.1 Construction

Information about the construction is less detailed than in the previous case about Amsterdam. An MCI calculation has not been made as well. DE STEK is a new building in an existing exterior, the former technical school of the city. A true transformation combining former architecture and installations in a new design. The interior of the building has been partly realized by Leerbouwen, the vocational school that is located on site. In the construction, it was decided to reuse as much as possible, just like in Amsterdam (RHDHV, 2020).

''Initially, the main ambition was 100% gas-free in Groningen, as this is a rather sensitive topic in this region. After that, the main ambition was circularity because we wanted to reuse as much of the building as possible and teach the students at the vocational school how to transform an industrial building into a modern office in a circular way.''[42]

According to Fr, there is a chance that a higher MCI score was achieved at this location than in Amsterdam because the entire building has remained intact.

''I think that the office in Groningen scores higher on the MCI scale because it contained even more reuse than Amsterdam. For example, the facades, supporting beams and the roof of the building have been completely reused.''[43]

The largest part that has been newly added via primary raw materials, looking at mass, are the windows. This was necessary to meet the sustainability standards as the old windows did not provide sufficient insulation (RHDHV, 2020). Furthermore, the walls/frames have been reused where possible with the new windows. Fh explains that energy efficiency of old real estate is often a limiting factor in Brownfield transformation:

''Energy label / sustainability of old buildings such as industrial real estate is often the main motive for demolishing Brownfields instead of transforming them.''[44]

All the furniture in the building has been completely reused from previous offices. The bicycle shed has been circularly made by the Leerbouwen vocational school in which they have used only second-hand materials (RHDHV, 2020). In addition, the following has been carried out in the field of architectural work: the original facades have been refurbished, meaning they tackled the thermal

[42] Fr 10:01 14-04-2023 (author's translation)
[43] Fr 12:31 14-04-2023 (author's translation)
[44] Fh 21:12 14-04-2023 (author's translation)

bridges (places in a building that lose a lot of heat) and the airtightness of the building has been analysed and improved where necessary. Partition walls have been added between different tenants and between central facilities so that the space can be used optimally, but separate d offices are still created. The central technical rooms have been upgraded, including the sanitary blocks (delivered second-hand). Because the RHDHV office was a large open space, partition walls of recycled OSB were added with cladding to improve sound insulation / absorption. Call booths and internal meeting rooms have also been developed. Finally, the entire floor of the building has been tackled to increase the insulation capacity (RHDHV, 2020).

The part that RHDHV is renting:

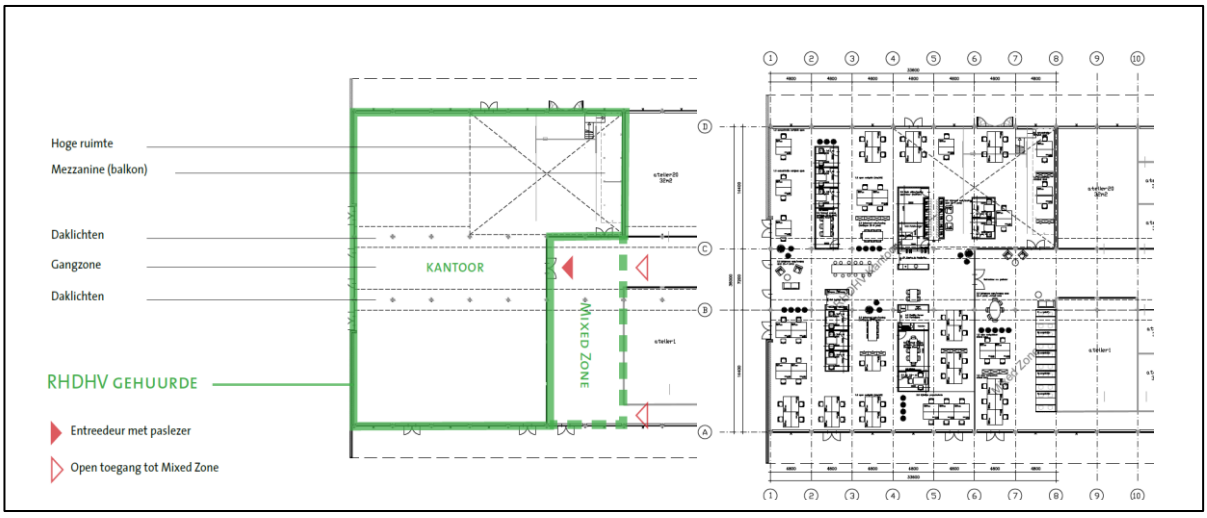

Figure 23: Floorplan of the RHDHV office in DE STEK building, retrieved from (RHDHV, 2020).

The following design animations illustrate how the office turned out after construction. They managed to create a modern office with plenty of natural lighting to create a comfortable and healthy working environment. Yet, the old structure including the yellow supporting beams, also present in the former building, are still clearly recognizable. A modern and innovative working environment created in a site of industrial heritage.

Figure 24: Design animation of the RHDHV office Groningen, retrieved from: (RHDHV, 2020).

4.3.2 Operationalization

Sustainability, inclusiveness and of course, circularity are central in the operationalization of the building. Starting with the daily cleaning where sustainable resources are used with minimal chemicals. The cleaning is carried out by employees who are lagging on the labour market to give them an opportunity to get back into the working society. The coffee is a shared facility that the entire building can use. By sharing such facilities, a higher usage intensity can be achieved, making it more efficient per unit resulting in fewer use of raw materials meaning it has a lower CO2 footprint. This also fits within the CE mentality: reuse and refuse (RHDHV, 2020). As Fr also states:

''The building in Groningen had some overcapacity, we have said that we will cut back on some of that overcapacity and the budget that is released for this will be spent on our ambitions. By means of this construction, we can use the space more efficiently and therefore facilitate and finance circularity. ''[45]

In addition, the coffee/tea is of sustainable origin with the fair-trade label, and the coffee cups are completely circular: they have a closed loop lifecycle because it is reused as toilet paper afterwards. The catering is vegan to minimize the environmental impact in the food industry as well. Furthermore,

[45] Fr 09:22 14-04-2023 (author's translation)

disabled employees are used in the catering to enhance inclusivity. All in all, the communal space has been designed in a circular manner by facilitating multiple and mixed use of space, thus reducing the total use of facilities / raw materials. The building is 100% gas-free, something that had to be achieved keeping in mind the regional conflict. And due to smart internal and external collaboration, it is also a waste-free building (RHDHV, 2020).

Sustainability is not only achieved in materials but also in energy. This building has an energy label of A++++ which is made possible by the 1,000 solar panels on the roof, 2 geothermal heat pumps and excellent insulation, namely: HR ++ and triple HR glass in all rooms, to ensure minimal heat loss (RHDHV, 2020).

In the field of mobility, sufficient charging points for electric cars have been considered and sufficient bicycle parking spaces to stimulate bicycle use. In addition, the bicycle shed has been made completely circular by the local vocational school. The outdoor area is equipped with outdoor workplaces and the original canal has been restored to create a place that can also offer enough relaxation in a natural environment. This office can be considered a working place of the future that fits within the CE seamlessly, because in the end, the circular economy is not only a society that reuses materials as much as possible but is a combination of a holistic way of thinking were social and environmental values are ensured through inclusivity and sustainability. Fr confirms that this office followed this way of thinking and Fh explains how this could be operationalized:

''Level ambition in the field of circularity, which was more a combination of several facets. For example, the owner of the building wanted the learning ability of the students to benefit by doing everything circularly as much as possible. A combination of ambitions and a balance between them is important for an inspiring and future-proof working environment. Circularity is only part of this.''[46]

''Planners from other areas of expertise should be involved in the transformation process to create a building that can fulfil multiple functions and facilitate mixed use and stimulate out of the box thinking to make sure the place has been designed holistically.''[47]

However, financing such ambitions is always a challenge because sustainable and circularity motives often do not comply with quick revenue especially in the corporate business. Yet, RHDHV managed to make this project financially viable by applying the same housing strategy as in Amsterdam.

[46] Fr 10:40 14-04-2023 (author's translation)
[47] Fh 50:44 14-04-2023 (author's translation)

''Initially, the building was very outdated, which means that it has a lower investment value. Secondly, it is also not an A location where multinationals like to settle. As a result, the acquisition of the property was cheaper, and we were therefore able to invest more money in value appreciation through renovation and circular transformation.''[48]

''We also did the plan development ourselves, so that we can arrange a lower rent with the property owner.''[49]

Something that Tb also stated in the previous case but also regarded this case is the timely and costly planning procedure that occurred before the actual construction and should be improved to make circular transformations more financially attractive, Fh and Tb quote the following:

''But you also see that these developments take an awfully long time, for example the development of the Albertpark site. These are peripheral issues that make Brownfields less attractive.''[50]

''A suggestion could be to add a legal step to the zoning plan procedure to consider if reuse can take place first. So, take a good look at the possibilities for use before demolition takes place. Because this is not common practice, it cost us a lot of time and money to see how we could reuse the building.''[51]

These complications make those circular and sustainable transformations of offices a challenging task.

[48] Fr 21:38 14-04-2023 (author's translation)
[49] Fr 23:44 14-04-2023 (author's translation)
[50] Fh 3:05 14-04-2023 (author's translation)
[51] Tb 24:40 12-04-2023 (author's translation)

4.3.3 Conclusion

Several lessons can be learned from the following case study. Regarding the end user in relation to the local culture, the trust between the company and the local users must grow, this can be achieved through interactive co-creation sessions in which actual steps are taken that deliver results: not words but deeds. This brings the company's vision closer to the employee, who is ultimately the end user and must therefore propagate that vision. As seen in this case, every region has its identity and its issues (gas conflict). When creating a tailored working environment this should be considered because it will make the employee more eager to come to the office. Responsible and circular use of space and use of facilities will also benefit from this. The aim of these co-creation sessions is also to find a balance between personal preference (regarding working environment) and the common goal of the corporate (about circularity and sustainability). Collaboration is crucial here, not only internally but also externally (with other tenants). Community building within the location will make it easier to achieve the common goals.

''You make an office that fits the identity of the local people, the vision of the company is secondary in this.''[52]

In creating a modern and future proof office, it is often necessary to find a balance between commercial purposes, aimed at rental revenue, and community building, aimed at social value creation. Circularity is in this occasion only part of the vision. And as seen from this case, even if circularity is not the main goal, great MCI values can be achieved. Sharing the same facilities and being present on the same floor will increase social cohesion within the building and increase the chance of succeeding in reaching the common goal. It furthermore makes the use of space more efficient and therefore more circular.

Regarding the constructional aspect in relation to circularity, this case can serve as a good example for other situations. Preserving the old industrial carcass is indeed possible, even if a modern office is to be made of it. If the preservation and reuse of materials is of paramount importance, but also a healthy, efficient, and social working environment, unique offices can be created. Often the planning process prior to the actual construction is the most difficult in circular transformations of industrial real estate especially when energy efficiency and sustainability are prioritized because they tend to clash now and then. The apparent complexity and the associated increased duration often seem to make such projects too risky, especially if a development is focused on a profit motive. However, in

[52] Fr 11:43 14-04-2023 (author's translation)

practice it often turns out that the bottom line is that not more costs are being made compared to new constructions. Creativity and inventiveness go a long way.

There are a few lessons to limit expenses in construction as well as in the operationalization phase. Picking a location that is not yet a hotspot can save a lot of acquisition costs and thus provides more opportunities for investments and value increase. Also, sustainability and responsible use of resources can mitigate operationalization costs. Developing your own office together with the owner of the building can also lead to lower monthly rental rates. After all, circular transformations will not necessarily mean more project costs, it only requires more expertise, patience, and planning. These challenges could be reduced if such developments are adopted by the public and therefore normalized. Government policy can enhance this circular transition by introducing facilitating laws and regulations such as the zoning plan procedure discussed by Tb and El.

Overall, the concept of an integral office approach, showed in this case, illustrates how corporate housing can mean so much more than only a building where people work. It is the central point of all the activities (figure 22) regarding that company, the customers, the employees, and other tenants. By seeing it as a society on its own, a holistic and healthy working environment can be created where future proof values such as inclusiveness, sustainability and of course circularity are taken into account.

4.4 RHDHV office Delft

The following case study is about an office location that is still under development. The development concerns a renovation of the former monumental faculty building of mining of the TU Delft. It is a new location in a new city, because the current offices of The Hague and Rotterdam will merge in this office. This project will become a real showpiece of RHDHV because the scale and the challenges are significant: transforming a monumental building that is over a hundred years old into a new sustainable office is quite a job. The high sustainability ambitions in combination with circularity and reuse in a building that has a monumental status makes this a complex case. RHDHV wants a future-proof building for 2050, which is why they have opted for the ambition ''Paris Proof'. An ambitious goal because it will become the first monumental building with this label in the Netherlands. On May 16, 2022, the redevelopment of the new location started. The building, dating from 1912, will be the new home base for up to 800 employees. The completion of the building is planned for mid-2024. According to Tb, RHDHV also preserved real estate heritage in this project:

''If we had not bought this building at the time, it could well have been demolished, there was a chance.''[53]

Figure 25: The former Mining faculty of the TU Delft in 1912, retrieved from: (Vlerken, 2023).

[53] 'Tb 11:49 12-04-2023 (author's translation)

The building was purchased at the end of 2021 by RHDHV., which holds several functions in this realization. Firstly, they are the client and owner, but they also participate in the design and implementation. In this project, they are partly architects themselves, but also called in the architectural firm Braaksma & Roos for the restoration and renovation part. The physical implementation of the project is done by SPIE Worksphere. According to RHDHV, this is a conscious approach that was also used in the previous cases as Fr quotes:

''With this we want to show what we can do, see it as a kind of business card to the customer. Lead by example in the sense of practice what you preach in enhancing society together.''[54]

Wo and Fr highlight why the choice for a Brownfield development has been made and how the municipality played an important role in the realisation:

''There was also talk of doing a Greenfield development in Delft because a new business park is being developed nearby, but we abandoned this because we felt it did not fit the vision of our company and the message we want to convey to the customer. It would of course have been cheaper, but with a view to practice what you preach and being a frontrunner in the field of circularity and sustainability, this was the right strategy. The Municipality of Delft also assisted us in the development by granting us an exception to the zoning plan regarding permits, so that we could still realize a company at an educational destination.''[55]

''In this development, we had to get through a change of use at the municipality: societal to office function. Fortunately, the municipality was kind and gave us that permit because with this development we contribute to solving the vacancy and make the area more dynamic.''[56]

This shows the willingness of municipalities to stimulate Brownfield developments if there is a good business plan.

The building, dating from 1912, is insulation wise a nightmare. It is an eight-shaped building with high floors, lots of single windows, many facades, and roofs, resulting in a lot of energy loss. Beforehand, it was carefully examined which ambitions were feasible for this building, which ultimately resulted in the label ''Paris Proof''. For an office, this means a maximum energy consumption of 70kWh per m2 of user space. Note: this is only the energy required for building-related installations, such as heating,

[54] Fr n/a 24-03-2023 (author's translation)
[55] 'Wo 16:04 17-04-2023 (author's translation)
[56] Fr 37:49 14-04-2023 (author's translation)

cooling, lighting, ventilation, and user energy such as telephones and laptops. This should make the building future-proof towards 2050.

Also, on the TU campus the office will become part of the valuable tech innovation community consisting of thousands of researchers, entrepreneurs, and students. This is one of the unique features of the office as it provides a study facility for the students as well. Especially in the weekends, when the employees are away, the building remains open for students to use as study area. In this way RHDHV fulfils their ambition of multiple/ circular use of space. As El quotes:

''In the weekends and after 5pm, the building is empty because all the employees are at home. It remains open for students, so we use the building as efficient as possible throughout the week. This is part of the circularity strategy because we repurpose and reuse the workspace. We also want to connect with the students because they fit within the work ecosystem of RHDHV''. [57]

''The Delft Campus is the place to be for us as consulting engineers. We can easily collaborate within the Delft innovation ecosystem and attract new talents.''[58]

''As far as I am concerned, the Delft office has an excellent location. It is of course close to the university, where we want to involve many students and with whom we want to exchange a lot of knowledge. We also wanted a circular building, which of course gives a fantastic appearance as a company.''[59]

The building furthermore provides space for small start-ups or companies within the same ecosystem as RHDHV so cross-pollination and cooperation can be facilitated.

''Multiple use of space by providing room for students and other companies within the same business sector''. [60]

[57] El 6:37 12-04-2023 (author's translation)
[58] Fe n/a 03-06-2022 (author's translation)
[59] Wo 15:21 17-04-2023 (author's translation)
[60] Fr 18:53 14-04-2023 (author's translation)

4.4.1 Construction

An important aspect of this building is the fact that it has a monumental status, this limits in a certain way the architectural possibilities in the redevelopment:

''Because the building is a national monument, we are not allowed to make any architectural changes to the appearance."[61]

An important element in the renovation is the covering of the inner gardens. The new office demands more space as it has to offer a working place for a maximum of 800 people, something that is not possible with the current floor space. The roof will cover the former inner gardens which will therefore become part of the building. Because the roof has a reasonably good RC value (this is the thermal resistance of a certain construction and therefore indicates the insulating capacity), it also contributes enormously to the total insulation which means that the facades adjacent to the courtyards do not have to be insulated further. The roof has also been approved by the monument care agency, something that took a lot of time and effort, according to Fr. The roof is however one of the biggest contributors of new materials in the construction. Although the supporting beams are made of recycled steal, the circularity value of the total construction will decrease. This is a conscious decision says Fr:

''We did not consider reusability with the glass roof, and we did not make it demountable either. This was a conscious choice because we know that it will be there for the next 30 years anyway and the chance that it will fit on another building is also not that plausible. We could have chosen to make the frame and beams from recycled wood, but this was technically almost impossible. So, we are constantly considering whether we can reuse something.''[62]

The floors and roofs will also be insulated from the inside and new double windows will be installed in the existing window frames and triple windows in the new building parts on the outside of the building. The atrium that will be created because of the solar roof gives an outdoors environment with a cafeteria and several meeting rooms made of wood who are easy to disassemble. This demountable design makes repurposing them in the future a lot easier.

[61] Fr 15:45 14-04-2023 (author's translation)
[62] Fr 16:51 14-04-2023 (author's translation)

''For the design of the atrium, we incorporated Leesman's research into primary needs within an office. As a result, we included the following aspects: acoustic comfort, sight lines were very important, natural light and sufficient workplaces. It's not just about a hip environment, office comfort is more important.''[63]

''We make an intelligent assessment of whether it is feasible to do something circular, but in principle

we already have a very strong story in terms of reusing a building from 1912. This is already circular, and I think that 95% of the walls, floors and ceilings have been reused.''[64]

Figure 26: Model of the roof covering the courtyard, retrieved from (Vlerken, 2023).

Figure 27: Cross section image of the roof covering the courtyard, retrieved from (Vlerken, 2023).

[63] El 25:50 12-04-2023 (author's translation)
[64] Fr 18:55 14-04-2023 (author's translation)

Figure 28: Atmosphere impression of the atrium, retrieved from: (Vlerken, 2023).

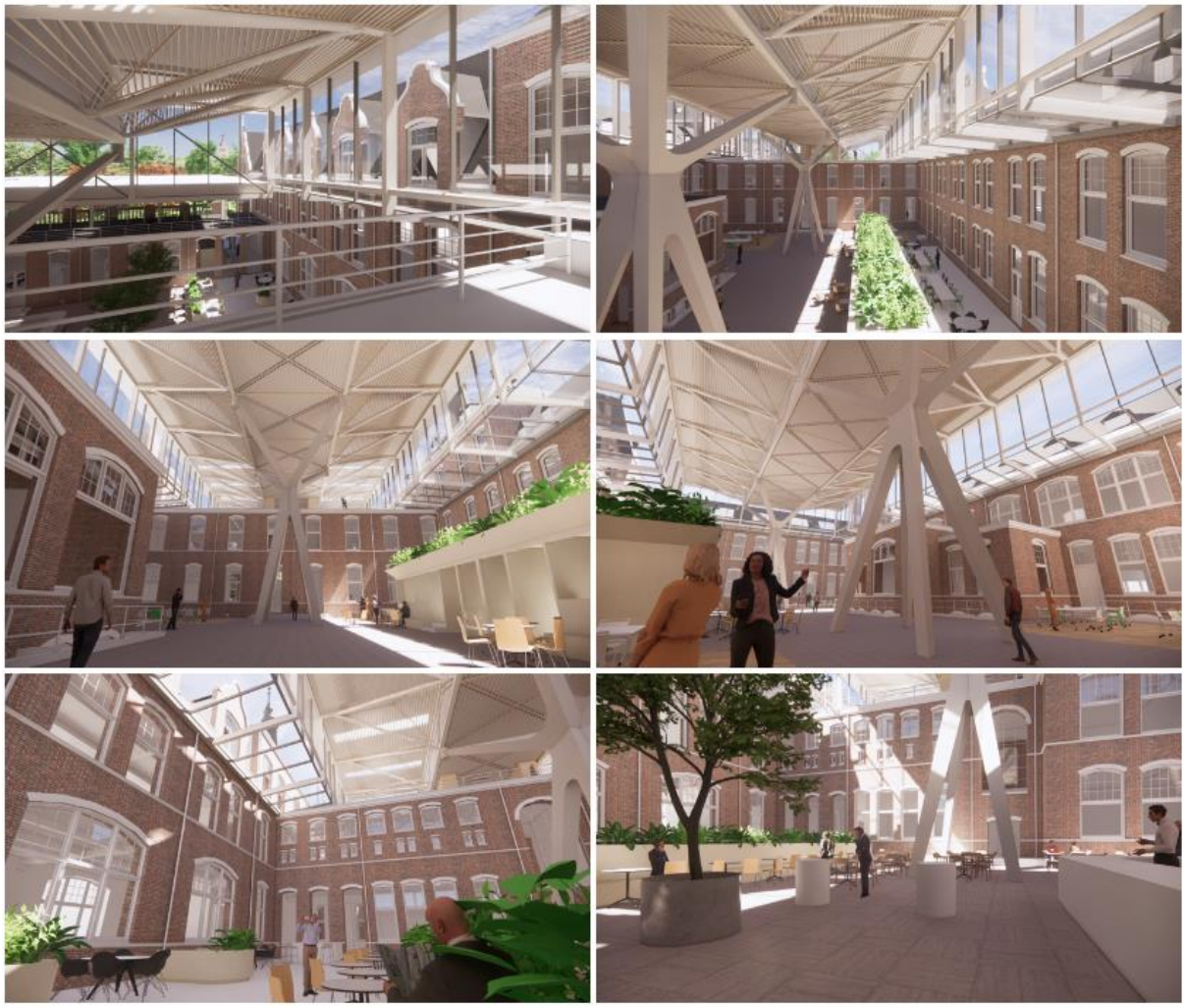

Figure 29: Atmosphere impression of the atrium, retrieved from (Smedts, 2023).

RHDHV harvests materials from their former offices and other office buildings that have spare office amenities such as desks, computers, and storage closets (see figure). If there appears to be need for more materials, natural materials such as wood is used a lot, and items are chosen that are designed and made to be taken apart for future reuse.

Figure 30: Notification letter which states that the closet will be removed to another office soon, retrieved from: (Verhoeven, 2023)

''If you look at the furnishing package, we say that we want to do everything from reuse, so it becomes circular. All fixed furnishing elements that are now being added will become circular.''[65]

Apart from a conservative monument care agency, which hampers the project progress, some other complications occurred which are common when renovating an old Brownfield site. During construction, they were confronted with unexpected asbestos and chromium 6, and old way to treat surfaces of plastic and metal. To create a safe working environment, these materials need to be removed or at least be covered to prevent exposure to employees. Also, higher prices for construction materials and labour do challenge the business case of this project. Another challenge, which also occurred in the other cases, is finding the balance between circular targets and the energy performance the building should deliver. As mentioned in previous chapters, the energy transition and circular materials transition can hinder each other. An example given by Mv and El:

''To save energy, the building will be insulated more, and solar panels will be installed. By doing this, materials are added to the building which limits the MCI percentage. Ultimately, the goal should be to balance operational and material-related emissions: whole life carbon.''[66]

[65] Fr 16:30 14-04-2023 (author's translation)
[66] Mv n/a 31-03-2023 (author's translation)

''The choice of second-hand materials can conflict with sustainability objectives in view of the product's lifespan.''[67]

''There are other challenges, which teach interesting circular lessons. For instance, bio-based insulation material is thicker, so it does not simply fit into the cavity wall of a monumental building. And there is a desired comfort of the end users, there are the requirements for national monuments and there are budgetary limits.''[68]

The following quote illustrates again (also seen in previous cases), that retrieving second hand materials can be quite a challenge:

''We are experiencing difficulties in finding the right materials that are second-hand at the same time. Luckily a system wall that is currently used in Rotterdam fits in the new office in Delft, otherwise we had to pick a new one''. An additional problem that occurs with this is intermediate storage of such materials, it makes it more expensive. [69]

One of the biggest sources of waste was changing all the single glazed windows to double glazed windows. Currently they are debating what to do with all the left-over windows. Some suggestions were mentioned by Qh:

''Because we want to minimize our material waste footprint, RHDHV is currently questioning what to do with the removed windows. They could be used in the interior as partition walls between rooms or be recycled into a floor for the atrium or be used in art pieces to decorate the office.''[70]

[67] El 36:49 12-04-2023 (author's translation)
[68] Mv n/a 31-03-2023 (author's translation)
[69] Fr 32:40 14-04-2023 (author's translation)
[70] Qh 16:45 14-03-2023 (author's translation)

Some other initiatives that enhance the project's circularity performance: old steam radiators are reused and being made operational in the new heating system. The old floors and ceilings of the building are preserved to create a unique working environment. The trees in the courtyard are chopped down and the wood is used for meeting room tables. See following images:

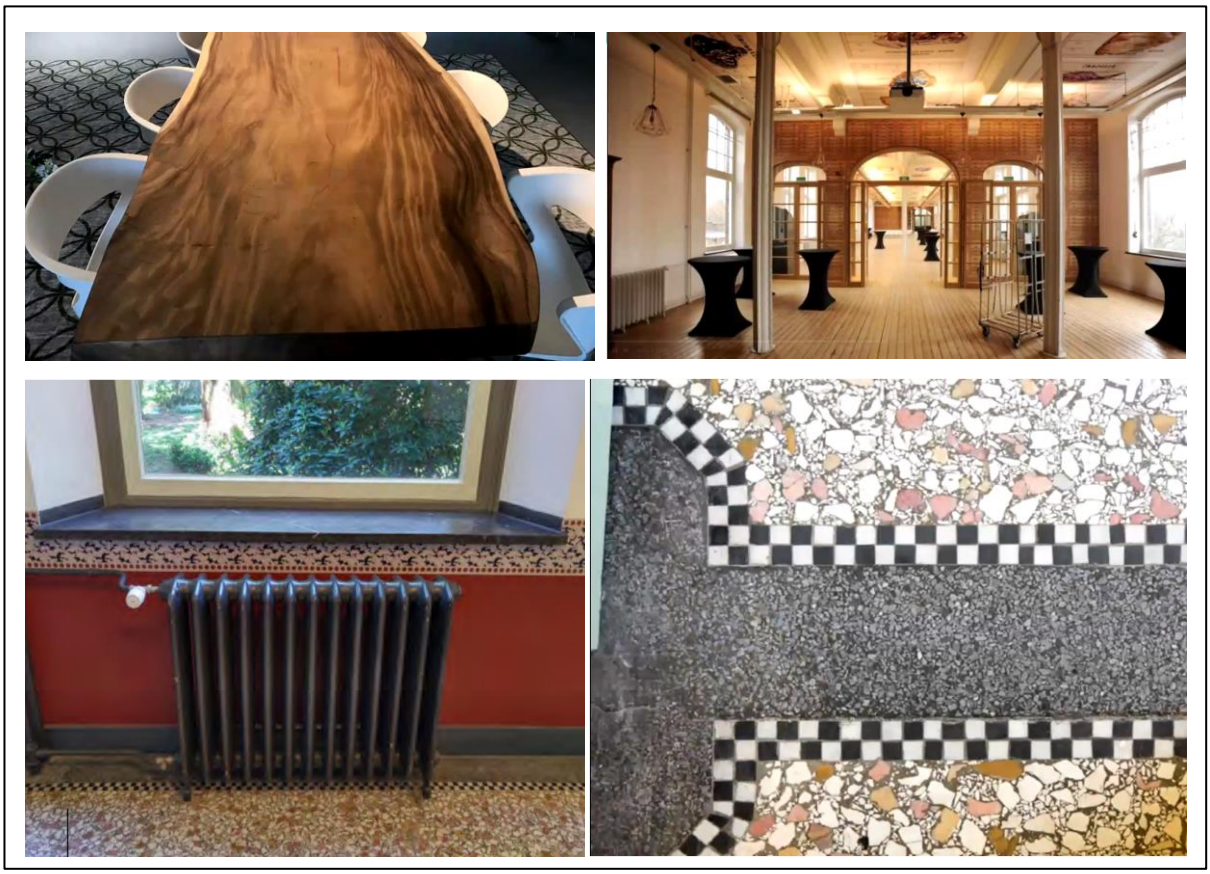

Figure 31: Reuse examples of the Deflt case, retrieved from: (RHDHV, 2023)

The physical design of the working environment is dynamic and purpose specific. This means that there are different areas to serve different purposes. For example, the floorplan is designed to facilitate different styles of working, from working or being in a call privately (no noise disruption), to an open desk setting in which colleagues work individually but are in the same room together (background noise), to convention areas and iRooms where meetings can be held, and presentations can be given (noisy atmosphere). This dynamic setup has been seen in the previous cases as well and has shown the effect on creativity, innovation, and cooperation. See the following floorplan for an illustration:

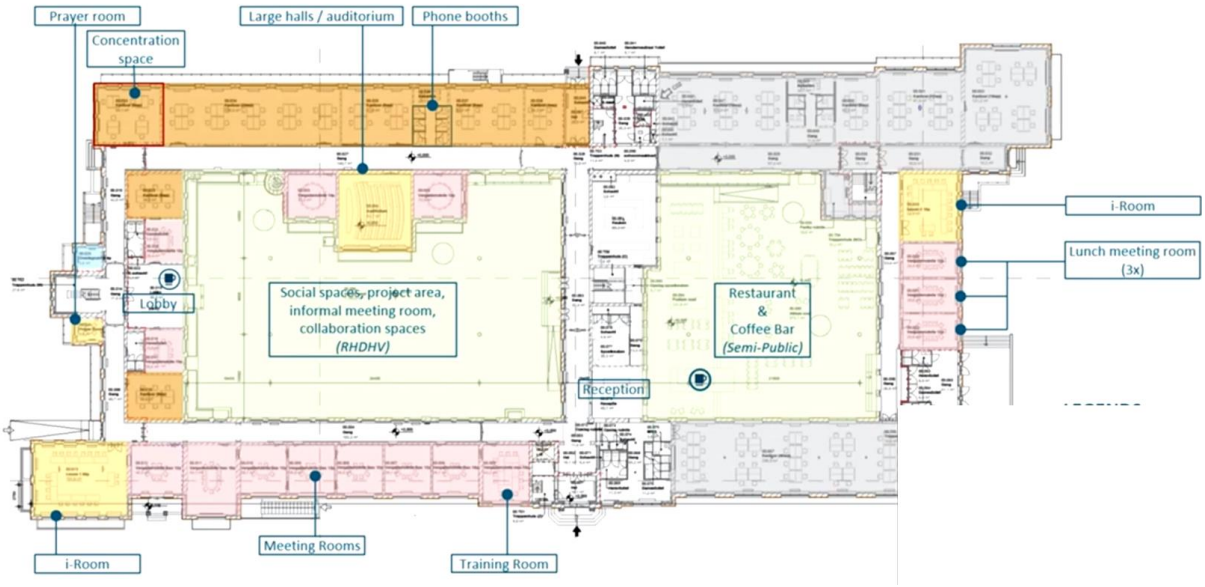

Figure 32: Floorplan RHDHV office Delft, retrieved from: (RHDHV, 2023).

''An open work environment where chance encounters take place and is very important for our innovative capacity and involvement between people and groups, so to speak.''[71]

''The character and type of building is important, which contributes to an inspiring working environment.''[72]

''That counts much more, because housing is about 1/10 of the operational costs compared to personnel costs. So, investing in staff welfare saves a lot of costs, which can be invested in housing, which reduces personnel costs. Investments in an inspiring environment, creative building, circular environment pays off in the well-being of staff, which ensures lower operating costs. This also makes circular developments more rewarding.''[73]

''We want to draw our colleagues to the office by providing a comfortable working environment and a building with its own identity, because nowadays working from home is really tempting.''[74]

The following images illustrate the different room designs.

[71] El 8:43 12-04-2023 (author's translation)
[72] El 26:58 12-04-2023 (author's translation)
[73] El 33:05 12-04-2023 (author's translation)
[74] Fr 27:22 14-04-2023 (author's translation)

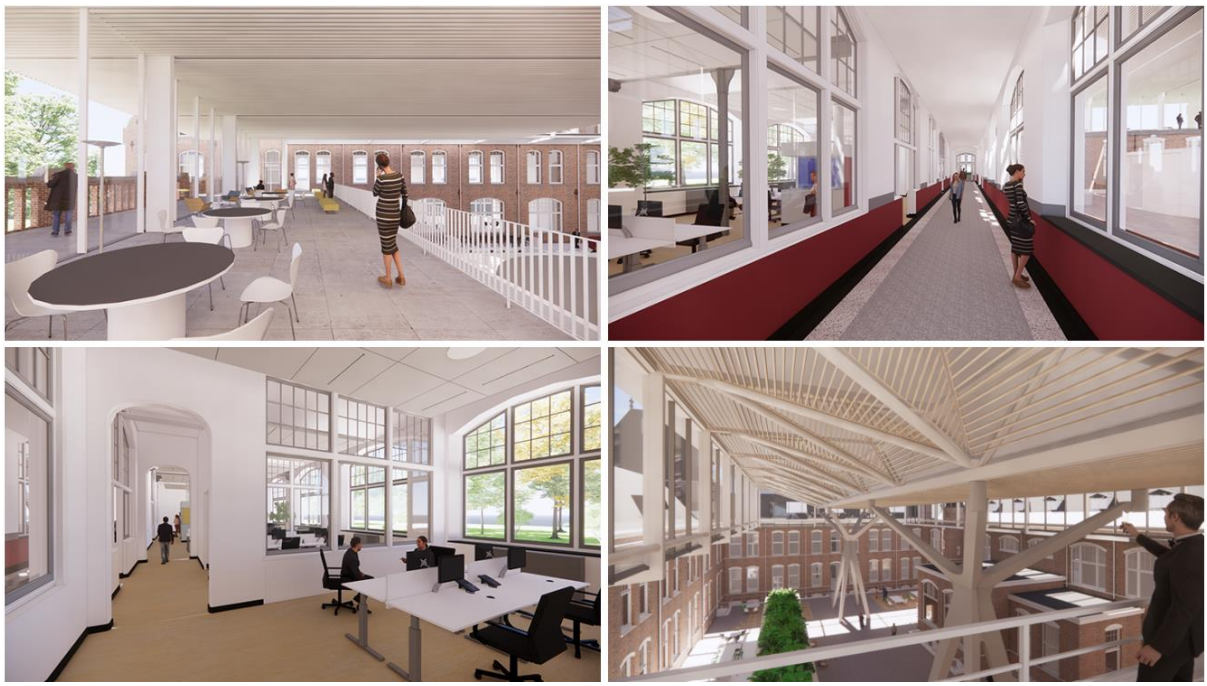

Figure 33: Design images office rooms Delft 2024, retrieved from (RHDHV, 2023).

So, circularity is infested in the redevelopment of the former mining faculty building. Specifically, RHDHV wants to reach an MPG score of less than 0,7 which is calculated in CO2 emissions per m2. Less than 0,7 will mean the total CO2 impact of the building must not exceed 250kg CO2/m2. This is firstly achieved by ensuring as much of the material used in the building does not come from primary resources thus have been obtained circularly. Secondly, this score is achieved by ensuring the operationalization of the building is as sustainable and climate proof possible. This will be further enlightened in the following chapter.

At last, an interesting aspect of the construction process of this office are the co-creation sessions that happen every few months. With employees from the former offices (Den Haag and Rotterdam), a gathering is arranged where they can provide input for possible design ideas and express their needs for their future work environment. Furthermore, the development team responsible for the project gives a webinar every few months to enlighten the whole company about the progress that has been made, obstacles that are being encountered and innovations that are being made. There is also time during these webinars for employees to ask questions and to give feedback or provide ideas.

4.4.2 Operationalization

Although the project is not yet in operation in real time, there are already a lot of plans which will ensure the operationalization of the office will be sustainable and as circular as possible. Community building and cooperation are also part of the strategy to ensure a healthy and bustling work environment is created.

For the heating, the building is connected to a thermal storage system, where energy is extracted by pumping up groundwater. The building is currently still heated with gas boilers but will be completely off gas and switch to low-temperature heating and high-temperature cooling. The investment of the thermal storage system will be earned back within about ten years and is crucial for the realization of the Paris Proof label.

''To make the building future-proof and functional in terms of operationalization, we had to make many adjustments. There was no cooling, little fresh air, and little room. Initially, therefore, not suitable for a modern office. Reusing the building is circular, but it was not future-proof and circular construction is nothing more than making existing buildings future-proof."[75]

Processing the thermal energy storage system in this building was quite a challenge, especially how all the installations in the building could be processed and how the monument care agency would agree to this. Most of the cooling is provided directly by the soil. In addition, they also use air-to-water heat pumps that can extract heat from the ambient air. But these pumps are mainly used as a peak supply, for example during cold winter days, as an emergency facility or for restoring the soil balance. In almost the entire building, the delivery goes through climate ceilings, where various techniques such as: lighting, heating, ventilation, sprinklers, sensors, smoke detectors and Wi-Fi points come together.

''The installation is completely new and has a huge focus on ease of use and is therefore end-user-oriented. The building is only cooled when it is in use, the building only gets fresh air when it is in use, etc.''[76]

These implementations can be considered as rather expensive investments but will return its investment in the long run. This is due to the operational approach according to El:

[75] Fr 21:05 14-04-2023 (author's translation)
[76] Fr 16:08 14-04-2023 (author's translation)

''If you are a plan developer yourself, you can invest in sustainable materials. This initially requires a higher investment but will ultimately save operational costs because the materials last longer. Developers who are solely responsible for delivery will use cheaper materials.''[77]

Wo highlights the other side of developments where financial incentives are the main driver:

''I am in daily contact with investors and developers, and I find it shocking how little incentive they have for sustainable or circular developments, if it is 1€ more expensive to go green, they will not do it.'' [78]

Private developers and investors are therefore currently not the ideal partner in circular/ sustainable developments. A strategy that RHDHV also applied in this case is choice of relatively cheap locations:

''The property is not in a developed location. It was therefore not an A location, which means a lower investor value and therefore less money spent on acquisition. This left more budget for renovation and transformation.''[79]

''For example, the property value has gone from 3 million to 50 million, but we have also invested a similar amount.''[80]

The building was not equipped with ventilation, so a completely new air treatment system had to be installed with three new air treatment units. RHDHV wanted to minimize the impact of these installations on the building, which is why they are going to place them in the middle of the building, because then fewer pipes are needed, and the diameter and surface of the channels is also limited. The Paris Proof ambition is not just a design ambition, but RHDHV also wants to realize it in practice by checking and monitoring afterwards. This is an important difference with many of the current methodologies. RHDHV will map the energy flows of the building to test the predetermined goals in practice. One way to minimize energy consumption is for example a demand-driven technology. When no one is in the room, it will hardly be lit, ventilated, or heated.

The lighting will also be experimented with. Upon entry, it will be set to 100 Lux, while the NEN standard (Dutch Norm for lighting) prescribes 500 Lux. The goal is to average about 300 Lux. To generate electricity for the building, the atrium roof is filled with solar panels. They are also looking

[77] El 34:08 12-04-2023 (author's translation)
[78] Wo. 17:31 17-04-2023 (author's translation)
[79] Fr 21:22 14-04-2023 (author's translation)
[80] Fr 22:08 14-04-2023 (author's translation)

into installing a battery so that the excess electricity can be stored instead of being fed back into the public grid. This strategy has the following financial advantage: when electricity is cheap, you can store energy and use it when electricity is expensive. The battery must be placed outside, at the parking lot because it is cheaper than indoors, and it is also a better solution in terms of safety. A lot of investments in sustainability that according to Wo will pay off in the end:

''Investments in sustainability also pay off in real estate value, nowadays many companies are looking for sustainable properties with a certain certificate. As a result, the real estate value of the Delft office will also increase considerably.''[81]

The following image illustrates the main goals for the development and how big of a share they each represent.

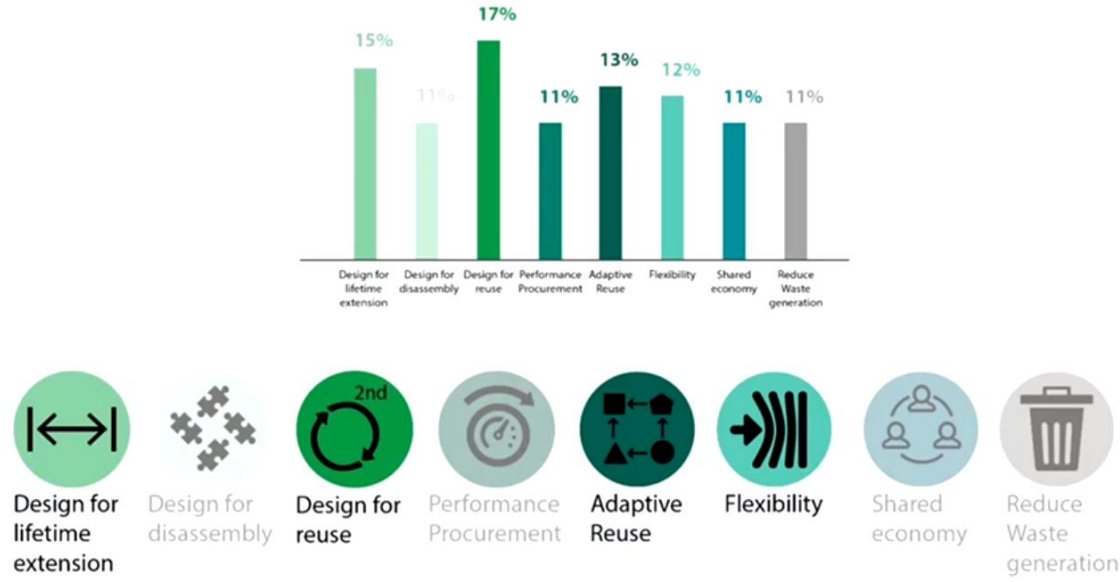

Figure 34: Goals of the development of the RHDHV office Delft, retrieved from (RHDHV, 2023).

At the end of 2023 there will also be a new tram line to and from the campus, which is also very favourable for the office. A good link with public transport, as shown in the previous cases, is a primary need for colleagues. El and Wo quote the following:

[81] Wo 27:10 17-04-2023 (author's translation)

''Good public transport connection and accessibility, but also that people can go outside during their break are primary office needs.''[82]

''The tram is reasonably around the corner now that it has finally been extended. That's great for colleagues who don't come by car.''[83]

At last, the office will also enhance local biodiversity by collaborating with the local botanical garden and the TU Delft in providing unpaved pavement and nesting possibilities in and around the building. In climate adaptation they try to make an impact by minimizing water usage and creating several water buffers to mitigate flood risk caused by heavy rainfall.

[82] El 22:30 12-04-2023 (author's translation)
[83] Wo 24:03 17-04-2023 (author's translation)

4.4.3 Conclusion

In the search for a Brownfield location, this case showed that a company will need to have intrinsic motivation to commit to a circular transformation because it is still more tempting to develop on Greenfields. However, it also showed that the municipality is willing to legally cooperate in the development if there is a good business case. A suggestion from the previous cases that also applies to this case when it comes to getting companies convinced to do Brownfield developments is a mandatory step in the zoning plan procedure. This forces companies to first make a thorough analysis whether it is possible to redevelop an existing building instead of developing something new. This was also quoted by Tb:

''A suggestion could be to add a legal step to the zoning plan procedure or whether reuse can take place first. So, take a good look at the possibilities for use before demolition of a building takes place.'' [84]

Again, this case has shown that many challenges emerge when circularly redeveloping an old building into a new sustainable working place. Some of these risks are mentioned such as the presence of asbestos or chromium, poor insulation capacity of the building and inefficient floor design. This cased has shown that by thinking creatively and being willing to invest time and effort in the development, it is possible to make a monumental building Paris proof.

Challenges in retrieving, transporting and eventually storing materials that are obtained second-hand are also considered limitations of circular office redevelopment. In this case, the same suggestion was stated about the potential of a regionally organized material banks for second-hand materials which can serve as a hub to obtain materials for circular developments.

This case has furthermore illustrated the challenge to combine circularity ambitions with sustainability requirements. The more you invest in sustainability and therefore add installations or insulation, the less a development is considered circular because you add materials. Second-hand materials are also considered less durable and therefore less sustainable. This cased showed how a balance between these two is challenging but possible to reach. For example, all waste that results from construction is being considered for reuse first, if that is not achievable the refurbish potential is assessed and at last recyclability is being considered to ensure nothing is thrown away and the refore ''wasted''. A solution mentioned in this case to deal with inefficient floor design/capacity is adding the atrium to increase

[84] Tb 24:22 12-04-2023 (author's translation)

the total floor space of the building. If adding new materials to the building is inevitable, at least ensuring the design is easily demountable afterwards is one of the solutions this case showed as well. By doing so, the reuse potential of that object will increase.

Reuse of furniture from former offices is also being done in this case to increase the circularity score. However, if some furniture does not fit within the style of the new building, it is being repaired or refurbished. As this case also showed that a healthy and comfortable working environment is essential for the creation of a building identity. The identity of the building was also mentioned in the previous case to be an important factor in creating incentive amongst employees to come to the office regularly. Having a lot of employees on present in the office is thereafter shown to be important for cooperative capacity of the company. Something that is considered a real priority in this project and invested in a lot by designing the floorplan in such a way that it facilitates efficient and effective working while at the same time also facilitating cooperation and cross pollination with other start-ups and students to enhance creativity and innovation.

By making the building available for students and other companies and making areas that are accessible for both RHDHV and externals, flexibility and multiple use of space is ensured which decreases the total m2 needed and therefore decreases the CO2 footprint.

Investing in employee welfare by ensuring the office facilitates a healthy environment has shown to be an expensive task but worth it on the long term. It was mentioned that most of the corporate costs are employee-related so investing in office facilities will mitigate the largest portion of the costs. The return on investment will however not be seen after several years, but not unusual with long term strategies.

As mentioned before, making an old building like this sustainable and even Paris proof and energy positive is a significant investment both financially and time and planning effort wise. But also, not impossible as this case has showed. Easy fixes such as smart usage in for example lighting, ventilation, and heating (only go on when movement is detected), operational costs can be minimized. To do such investments however, it is necessary to deprioritize financial motives. Because RHDHV was responsible for both planning and construction but also end-user at the same time, they were willing to make these investments in advance. If a private investor, with a financial motive, is however responsible for construction only, there are reasonable chances the construction will be economized as must as possible which is not a healthy long-term strategy when it comes to sustainability.

Although it is considered a risky development financially and planning wise, this case has also showed some strategies to limit financial expenses. One strategy is minimizing operational costs and investing in sustainable self-providing energy sources such as heat pumps, insulation, and solar panels. Such investments also increase the real estate value of the building because Paris proof buildings are becoming more popular amongst the corporate market. Another strategy is choosing a building that is not yet located on a so called: A location. This saves acquisition costs which leaves more space in the budget for circular and sustainable investments.

In conclusion, this cased showed again that circular transformation of offices and creating a healthy and innovative working environment is a combination of several priorities. Sustainability, building identity, flexible floorspace design and use, cost cautious but long-term investment strategies, efficient operationalization, mobility, and circularity all play a role in this development synergy.

4.5 Case comparison

In this part, a brief comparison of the three cases mentioned above will be proved to serve as a summary of this chapter where the most important similarities and differences can be brought to light.

4.5.1 Similarities

Keyword	Explanation	Project phase
Material banks	In all three cases, respondents have mentioned how difficult it was to acquire second hand materials. The same suggestion of a central point where these materials could be acquired more easily was mentioned in by several respondents. This makes circular construction easier, more common, and therefore cheaper.	Construction/ renovation
Demountable design	This concept was mentioned in every case and basically entails that every construction that is being made in the office is designed in a way that it is easy to be disassembled. This makes reuse in the future easier.	Construction / renovation
Planning challenges	Each case mentioned the same challenges in planning of circular construction. Looking for best practices, acquiring materials and designing old buildings takes more time than new developments. This makes Brownfield still less favourable than Greenfield. Several ideas were mentioned to mitigate these challenges.	Planning/ design phase
Location	Each case is situated in an area that is not considered an "A location''. Because it is not yet a location that is highly wanted by other businesses, the acquisition price of the initial real estate is lower which leaves more budget for investments in sustainability and circularity. This is an advantage of Brownfield locations.	Planning/ design phase
Collaboration	In the interior design of each office, collaboration was one of the main priorities. Internal collaboration was stimulated by facilitating open working spaces and with several separate meeting units. External collaboration was stimulated by shared common spaces in the building that are used by the externals in the building as well.	Construction/ operationalization
Energy	Every office regarded green energy provision and sustainable energy use as high priorities. Because every building was insulation wise a nightmare, large investments had to be made to fulfil this ambition. This was done by smart heating and lighting installations.	Operationalization
Mismatch	In every case, the mismatch between sustainable ambitions and circularity goals was mentioned and examples were given. It can be said that it is a challenging task to circularly transform and old building while at the same time realizing certain sustainability ambitions regarding material and energy use.	Construction/ operationalization
Ownership	Amsterdam and Groningen showed the same ownership structure were RHDHV was only operating as developer and end-user, but not as owner of the building. This construction	Planning/ construction/ operationalization

	required a strong cooperation with a shared vision and ambitions.	
End-user	In all three cases, RHDHV is project developer and end-user at the same time. By developing your own office, they were able to execute everything according to their own vision and goals. Choosing the right materials for a sustainable future was being ensured. In Delft, RHDHV is also the owner of the building.	Construction/ operationalization
Cross-pollination	Each office has shared spaces and provides space for externals. Although the externals are different in each case, the concept remains the same. By mixing the employees of RHDHV with others, innovation and creativity increase through cross-pollination with the externals.	Operationalization
Shared floorspace	This is in line with the previous similarity. By providing shared floorspace with externals but also floorspace that is shared by several usages, operationalization circularity increases. The space is used more efficiently which means the need for more space is prevented.	Operationalization
Skin building	In every case, the exterior skin of the building remained untouched to keep the original identity of the old building. in Delft they were even bound by regulations regarding monument preservation.	Construction/ renovation
Interior	Every case used as many office amenities of the previous offices as possible to increase the circularity. First, the reuse potential was analysed of an object, if it did not comply with the design and aesthetics of the new office, it was repaired or refurbished. If that was not possible, it was recycled or downscaled as last resort.	Construction
Floorplan	The floorplan of each office is designed in a similar way with the amount of noise as main indicator. Large open spaces to promote collaboration, where a fair amount of background noise is present. Separate meeting or convention rooms where it can be reasonably noisy or individual or small meeting pods where one can work completely in silence.	Construction/ operationalization
Floors	Amsterdam and Groningen share the same ''one floor'' design. As seen in the cases and by the respondents, this design tends to enhance collaboration and cooperation within the office because everyone is on the same floor and can therefore interact with each other more easily.	Operationalization
City centre	All offices are located relatively close if not next to the city centre. This follows the new trend where offices like to be located close to the city centre instead of on the outskirts of town. Being in the city has its advantages on employees and the office's surroundings as seen in the cases and in the theory.	Planning/ Operationalization
Office use	This aligns with the multifunctionality of the offices, as the offices mentioned in the cases are also used in the weekends by the relevant externals. This again increases the space efficiency and therefore decreases the demand for more space which is more circular.	Operationalization

Branding	Each office worked on giving the building and the working environment its own unique identity. As shown in the cases and mentioned by the respondents, creating an identity that fits the local community motivates the employees more to come to the office which increases collaboration and innovation. This process was also called ''branding" by some respondents.	Operationalization
Regulations	Each respondent from the cases mentioned some suggestions to enhance the transition to circular developments by adding a legal step in the zoning plan procedure which forces a project developer to look at reuse potential of a building before it will be destroyed. This will stimulate circular development and make the planning process more common and therefore easier to implement and cheaper.	Planning/ design phase
Co-creation	All offices implemented co-creation sessions in the planning phase of the development process. Co-creation with employees from former locations to ensure the new office fits the needs and aligns with the identity of the community. In this way the office provides a tailored working environment for the local employee community. Designing an office with the end-user as highest priority is a visionary approach.	Planning/ design phase
Insulation	Each case showcased a particular challenge in insulation of the old building. This is a major downside of renovation old buildings to make them climate proof and energy efficient. Something that must be considered when starting a circular transformation.	Construction/ renovation

4.5.2 Differences

Keyword	Explanation	Project phase
Ownership	There is a difference in ownership between Delft and the other cases. Delft is the only case where RHDHV has full ownership of the building. In the other cases the building is privately owned by a separate company.	Planning/ construction/ operationalization
Externals	As mentioned, each office share some of its floorspace with external companies/students. Although the concept is the same, the externals are different in each case. In Amsterdam the externals are small start-ups in the creative and technical branch. In Groningen it is mainly filled by students from the vocational school, and in Delft it is a mix of small start-ups and students from the technical university.	Operationalization
Main goals	Each office has its own priorities regarding its vision and future work environment. In Amsterdam, circularity was the foremost goal in combination with a creative working environment. In Groningen, the foremost goal was creating an energy efficient building and inclusiveness by providing learning spaces for the less gifted. In Delft, it is a combination of circularity and sustainability while also wanting to create a knowledge hub with bright technical students.	Operationalization
Community	Amsterdam connects less to the surrounding neighbourhood/ community than Groningen and Delft. In the other cases, there	Operationalization

	is a real interaction between members of the surroundings, and they are integrated in the office.	
Municipality	Only Delft had an active cooperation with the municipality as they had to assists the development regarding the building permit and a change in the zoning plan. Because they had a good business case and really contributed to the liveability of the neighbourhood, this exemption in the zoning plan was granted.	Planning/ design phase
Extra space	In only the Delft case, the floor area had to be enhanced which was done through the construction of the atrium, to comply with envisioned capacity. The buildings of Amsterdam and Groningen offices had overcapacity which they used to house the externals. Delft had to be upgraded to ensure it would be sufficient to house 800 colleagues at one time and fit several dozens of students in there.	Construction

5.0 Discussion

In this chapter, each sub question will be answered following the empirical research. This is followed by an explanation how these answers align or contest with insights from the literature by delving into the meaning, importance, and relevance of the results in relation to the theory. Following from this are recommendations for further research.

5.1 Answer to sub question one

How is the relevant national and European policy framework affecting the circular redevelopment of inner-city Brownfield sites?

A question was asked during each interview in which the interviewer asked the respondents if they experience guiding policies regarding their development of brownfields. All of them answered that there is no active policy framework which guides, stimulates, or limits brownfield development in relation to greenfield development. Some respondents in the case studies addressed the preference of local authorities for infill development, but no hard regulations were mentioned. The Delft case illustrated how zoning plan policies can hinder certain brownfield developments because they do not fit in the current destination description and that close cooperation with the municipality is essential in this regard to let the development succeed. The most prominent policy that was mentioned quite often in the case studies is the Paris Proof label which is a requirement for new offices (Tuinenga, 2022). This affects the circular development of Brownfield sites quite significant as it was showcased that circularity and sustainability do not go along too well. Making a building more sustainable by adding durable materials and increasing its energy efficiency through insulation and sustainable installations decreases the circularity score of that development. The Paris Proof label aligns with the Green Deal policy mentioned in the theory which is coordinated from the EU (Sessa, Russo, & Sica, 2022). The other EU policies that were mentioned on page 21 and 22 and the Dutch ''NOVI'' policy on page 23 did not return in the interviews or the case studies. What some respondents did mention is the fact that more active steering from the local governments through laws and regulations could be beneficial for the transition to circular developments in the building sector. According to the literature this institutional structure is already present but apparently not operative in practice (Rijkswaterstaat, 2018). Especially actors such as private investors can use more incentive to implement more circular building projects. Financial challenges and planning complications were mentioned as the main reasons that most developers currently do not proceed with circularity in the building sector. Active policy could therefore be beneficial in this branch.

5.2 Answer to sub question two

How are the projects where RHDHV offices are relocated to inner-city Brownfield sites operationalized in terms of construction and renovation?

As seen from the multiple case studies that were executed, the projects follow a similar approach as the theoretical framework discussed in paragraph 2.2.2. It starts with an extensive planning and design phase which according to theory and respondents appears to be quite a considerable job compared to (greenfield) developments. Finding best practices, acquiring second hand materials, and renovating an old building take up more time and planning which appears to make it more expensive at first which is also mentioned in the theory on page 16 (Henderson & Raco, 2006). The cases furthermore showed how co-creation increases user friendliness. Designing the office around the end-user is a new concept that RHDHV applied to ensure the working environment is according to the needs and wishes of their employees, this was also mentioned in the theory on page 19 and 20 (Ginneken, 2023). Then there is the remediation phase which was not that special in the discussed cases because the former buildings were not categorized as heavy industrial. The only work that had to be done regarding the removal of toxins were asbestos or chromium related. Although anticipated in advance, it still slows down renovation works which causes extra costs as mentioned by Montgomery (2011) in the theory as well.

Then the renovation phase was executed which was done in a similar manner in all three cases. Most of the exterior skin and interior frame of the building remained intact to maintain the original identity of the building and reuse as much materials as possible considering circularity ambitions. Where necessary new installations, insulation or materials were added to align with current and future sustainability goals and comply with a modern working environment. Although the tricky part with having circularity and sustainable ambitions at the same time is that they contradict each other. New installations are sustainable, but it decreases the overall circularity. Office amenities were reused as much as possible from previous offices and second-hand materials such as meeting rooms made from containers. Logistically they all experienced challenges with acquiring second-hand materials externally. A suggestion was given to locally organize material hubs where second-hand materials can be easily acquired. Everything in the construction was mindfully put together with the future in mind: demountable designs to make it easier to disassemble in the future. This increases the so called ''promised circularity''. Only for the first case, actual MCI percentages where known which showshow much of the building's mass is circular (Stahel & MacArthur, 2019). It was shown that high percentages where reached. According to respondents, the Groningen case was scoring even higher on the MCI index.

5.3 Answer to sub question three

How are the projects where RHDHV offices are relocated to inner-city Brownfield sites currently operating and maintaining circular and sustainable standards?

The operationalization phases of the projects were mainly dominated by sustainable ambitions and creating/ maintaining a creative, collaborative, and innovative working environment. To start with sustainable ambitions, which was operated by ensuring the buildings have a low energy usage overall. By generating their own green energy and consuming no more than that, the buildings are energy neutral which means they do not need power from the public net. Proper insulation, a reasonable challenge considering the buildings were outdated, was also an important step in ensuring the energy usage of the building is as efficient as possible. Minimal energy loss results in fewer energy demands. Modern installations such as heat pumps and cold/ warm storage were used as well to have an efficient energy operation. Standard procedures such as separating waste, having own coffee cups and vegan canteens all contribute to the office having an as low carbon footprint and impact on the climate as possible. This aligns with the theory about the Paris Proof label (Tuinenga, 2022).

Considering the working environment, the offices all maintain an open and collaborative working sphere. In the design, the end-user was prioritized so it meets the needs of their employees and externals and the original identity was remained through branding. This enhances the group feeling, creativity and innovation according to respondents and makes the colleagues want to visit the office more often. According to the respondents, this is crucial to make the office an effective working place. The office floorplan facilitates collaboration by making different areas designated to cooperate and mix with other colleagues during individual work. Plenty of separate meeting rooms are also ensured and open places such as the canteens are open for externals as well. This is another concept in the operationalization that can be considered unique for these cases. RHDHV made their office available for externals such as start-ups and students to firstly fill up the extra space that was available in the building, but more importantly: facilitate cross-pollination and innovation with others. This idea align with the theory of Jacobs about a mixed environment (Jacobs, 1961). Through this concept, employees of RHDHV can link with externals within the same expertise and integrating with students is beneficial for knowledge sharing and future endeavours. The single floor design in Amsterdam and Groningen also contributes to the collaborative capacity of the office.

The location of the office also plays a role in operationalizing a modern working environment. The offices are all located close if not next to the city centre which makes it easy for colleagues to go for a

lunch walk in the town square. The respondents addressed that this is a big advantage of the new offices. This was also mentioned in the theory by Ginneken (2023) about the post-COVID office trend.

5.4 Answer to sub question four

Which lessons in circularity can be taken away from the case projects?

Some key lessons can be taken away from these cases. Firstly, some technical lessons that arise from the case studies are that redesigning an old building is a careful practise where preservation and reuse should be prioritized. The skin for example, should remain untouched as much as possible. Where necessary, add installations or insulation to enhance the sustainability of the building. But adding materials, and especially new materials, will decrease the overall circularity of the building. The cases showed that acquiring second hand materials is now a difficult job which can be made easier by organizing local material banks. Demountable designs will increase promised circularity because it will be easier to dissemble the construction afterwards. Reuse is always preferred over recycling or refurbishing because it requires the least amount of energy to acquire that material this aligns with the theory about 10R's of circularity mentioned on page 13 (Cramer, 2020). Especially in office amenities, reuse has great potential because the stuff can be acquired within the company. Finding best practices, logistics and planning make circular projects more challenging than new developments. And ambitions such as sustainability and energy neutral conflict circularity ambitions. Finding the right balance here is key for a good result.

Although circularity was the focus in this report, the cases showed that creating a modern working environment regard including much more aspects than that. It is a combination of several values and ambitions that shape the workplace of the future. Overall, the concept of an integral office approach, showed in this case, illustrates how corporate housing can mean so much more than only a building where people work. It is the central point of all the activities (figure 22) regarding that company, the customers, the employees, and other tenants. By seeing it as a society on its own, a holistic and healthy working environment can be created where future proof values such as inclusiveness, sustainability and of course circularity are considered.

5.5 Research interpretations and implications in relation to theory.

The results presented in the case studies are broadly in line with the theory discussed in chapter 2. Firstly, many aspects of the circularity ladder (10R's by Cramer 2020) returned in the practical cases. It could be noticed that reusing of materials was largely preferred over refurbishing or recycling because it takes less energy to do so. Redesigning an office with minimal interventions and

applications on the carcass was the way to go for RHDHV. The concept of reducing also returned in multifunctional use of space. Simultaneously, the concept of urban mining was noticeable in the cases as well, because in the Delft case, they aimed to have zero construction waste. So, everything that was removed from the building such as single glazed windows were given a new purpose and eventually downscaled in the end if there were no other solutions.

Spatial influences of these Brownfield developments were also recognizable in the cases as mentioned by Sessa, Russo, & Sica, 2022 in the theory. For example, apart from preventing building vacancy, the Delft case really revitalized the area by adding other functions to the area and combining work, retail, and knowledge driven technology in an urban area. For this reason, they were granted that building permit because the municipality realised, they were enhancing the spatial quality and liveability. Amsterdam contributed to the revitalization of the emerging innovative area of Sloterdijk and Groningen contributed to the local community by providing space for the vocational school. The concept of a multifunctional office with mixed use in the same building also aligns with J. Jacobs's (1961) theory about the benefits of a mixed neighbourhood. It is the same principle but then executed on building level. Another concept of Jacobs that was executed in theory in the cases was historical site preservation. All the buildings preserved the original structure, especially the Delft case because it is considered monumental heritage.

Furthermore, challenges of Brownfield development mentioned in the theory clearly returned in practice in the cases. Challenges such as extra project time, costs, remediation and material infrastructure and logistics were mentioned in the cases. Theory about the Paris proof label and the successive TENB label where a building should be completely energy neutral were also used as concept in the cases. All the offices of RHDHV had energy neutrality as one of their foremost ambitions. The theory explained that Paris proof is merely a beginning phase of eventually being energy neutral.

The theory about the pandemic influences was also clearly recognizable in practice in the cases. The theory addressed that nowadays many employees practice hybrid working and barely visit the office. RHDHV is contradicting this trend by making the office as appealing and comfortable as possible, so the employees are drawn to the office. Creating such a working environment is crucial for the creativity, collaboration, and innovative capacity of an organization. The theory confirms that modern offices are seen as a social place where creativity and brainstorming with other colleagues should be prioritized.

Theory about the EU policy frameworks appears to be lacking in practice in the cases as respondents addressed that there are no active and hard laws or regulations that regard circular office

transformations. Only the Paris proof label which indirectly follows from the green deal policy was mentioned quite a lot.

From the theoretical framework, the project lifecycle from Pediatiti et al (2005), relates seamlessly to the practical examples in the cases. The different steps in the project cycle were clearly recognizable in the cases. The theory from the framework for researching CE in the built environment (2.2.1) can also be applied in the result part. First, the research dimension meso-level (buildings) was very applicable in this research, but also micro level (materials) was recognizable within the construction. Acquisition of second-hand materials (supply) and demand were quite a struggle in the cases. As Pomponi & Moncaster 2017 also state is that research in the CE is subject to many frames, discourses, and biases. This was recognizable in the perception of the interviewees. Everyone perceives circularity and sustainability in a different way which makes it more challenging to draw general conclusions or theories from this data source. The different research dimensions such as behavioural (with regard to office end users), governmental (with regard to circularity and sustainable policies), technological (with regard to circularity practices in construction, renovation and energy provision and conservation), economic (regarding costs and budget challenges of circular transformations), environmental (with regard to minimizing carbon footprint of modern offices) and societal (general development of CE transition in the built environment) can be related to the cases.

The last framework about assessing the sustainability of Brownfield redevelopment projects by Williams and Dair (2007) was considerably present in the cases. The following highlighted sentences returned in the development of the RHDHV offices, the third column describes the project phase.

Sustainability assessment		
Economic sustainability objectives (Williams & Dair, 2007, p. 30)		
1. Enabling businesses to be efficient and competitive	*''Reduce energy consumption in construction.''* *''Reduce waste in construction.''* *''Minimize energy and water consumption.''* *''Provide developments with renewable energy power sources.''* *''Provide high quality urban design, including secure premises.''* *''Provide high quality buildings that are flexible and can be adapted with minimum costs.''* *''Provide transport infrastructure to meet business needs.''*	C C O C C C P
2. Promote local economic diversity	*''Provide higher densities to enhance commercial viability.''* *''Provide a mix of uses to increase viability and vitality of commercial areas.''* *''Enable a supply of properly serviced land and business premises.''* *''Use locally produced goods and materials in construction.''*	O

3. Support employment opportunities	*''Provide a mix of uses to give choice of employment.''* *''Develop high quality buildings for manufacturing and commercial activities.''* *''Increase the recruitment of local unemployed people.''*	O O
Social sustainability objectives (Williams & Dair, 2007, p. 30)		
1. Ethical standards during the development process	*''Ensure ethical trading throughout the supply chain of a development.''* *''Provide a safe and healthy work environment.''* *''Comply with labor conventions (non-discrimination/reasonable hours)''*	O O O
2. Provide adequate local services and facilities to serve the development	*''Provide space for training.''* *''Provide open space for community benefit.''* *''Develop good quality energy efficient buildings for community activities.''* *''Offer a mix of retail spaces.''*	O O O O
3. Provide hosing to meet local needs.	*''Develop a mix of housing tenure and type.''* *''Provide affordable housing.''* *''Provide high quality and flexible buildings that minimize the use of resources.''*	 C
4. To integrate the development within the locality	*''Provide multiple links to adjacent neighborhoods''* *''Reject or discourage gated developments.''* *''Create a mix of transport provision with a variety of modal links to services, work, leisure, and homes.''* *''Provide good access for people with disabilities.''*	O P O
5. To conserve local culture and heritage, if appropriate	*''Reuse locally valued buildings.''* *''Design developments to reflect local heritage and use local materials.''*	C C
Environmental sustainability objectives (Williams & Dair, 2007, p. 31)		
1. To minimize the use of resources	*''Use renewable materials, e.g., sustainably produced timber. Use recycled materials, e.g., aggregates.''* *''Use renewable energy sources, e.g., wind turbines, photovoltaic cells.''* *''Design developments for minimum waste during construction, life, and after-life.''* *''Use materials with low energy inputs.''*	C O C C
2. To minimise pollution	*''Remediate contaminated land.''* *''Reduce air pollution including dust during construction.''* *''Mitigate noise pollution both during and after construction.''* *''Provide infrastructure for public transport, walking, cycling.''* *''Raise densities on sites within 800 m of existing centres, services, and transport corridors.''* *''Design buildings for minimum energy consumption in use.''*	 P C
3. To protect biodiversity and the natural environment	*''Conserve flora, wildlife, and habitats on site.''* *''Provide wildlife refuges, such as ponds and wild areas.''* *''Use sustainable urban drainage systems to protect rivers and water courses from pollution and flooding.''*	O O O

Overall, the results provide a general pathway on how to execute circular office transformations on Brownfield sites. It fills the knowledge gap on how to apply principles of the circular economy on the building level (meso) (Pomponi & Moncaster, 2017) and for the post Covid office market specifically. Because this is an emerging trend, the results retrieved in this research can be considered scientifically

relevant. The results should therefore be taken into account when considering how to operationalize a similar project. Yet, the cases also illustrate how each project is unique on its own and should therefore be addressed as such. A tailored strategy for each specific case is the way to go.

5.6 Recommendations for further research

Following the earlier mentioned limitations, suggestions for further research can be to have a more a varying range of cases both in terms of origin but also quantity. In terms of origin, one could think of cases that have been conducted in different scenarios from different clients such as municipalities. Also, who executes the projects could be researched more broadly. Now, cases of just one organization have been examined while other cases such as Vasim Nijmegen or Strijp S in Eindhoven could also be interesting to compare to the cases analysed in this research. Although the purpose of those redevelopments was different (not only offices but also housing and cultural purposes), it would still be interesting to see the difference in the approach and the way these projects were executed in terms of circularity and sustainability. This would also increase the extensiveness of the case study which adds to the quantity of cases. This is necessary to really make statements about inner-city Brownfields for the whole of the Netherlands, this must be considered. The generalizability will improve from which the external and internal reliability will enhance as well. Secondly, more interviews could be conducted, especially in other sectors such as governmental actors. This side of the stakeholder composition has now been left out, and to really get a holistic view of those projects, these could be good actors to add. This would especially be beneficial in providing an in-depth clarification of the policy research question.

6.0 Conclusion

In this chapter the research will be concluded by answering the main research question. Resulting from this are recommendations following the results regarding the topic and the limitations of the research will be explained.

6.1 Main research question answered

To conclude the research, the following question is answered which provides the core message of this report.

> ***How are circular practices being implemented in the construction and operationalization phase of projects that turn inner-city Brownfields to modern offices in The Netherlands?***

Circularity wise, the research has shown some practices in the cases that were successfully applied and can be considered a best practice for circular office transformations on inner-city Brownfield sites. Starting with the planning phase, challenges regarding location and building potential can be overcome by analysing the building potential with several different expertise and thus looking at it in a holistic way. Brownfields located relatively close to city centres appear to be a good fit for offices in the creative and engineering sector. Overcapacity can be used to provide office space to externals as seen in the cases and under capacity can be solved by developing constructions that merge with the former buildings such as the atrium. With circular projects, materials are difficult topic as the aim would be to acquire everything second handed to remain within the ambition. As seen from the cases, this is a challenge that all circular projects in the Netherlands might face, because an organized infrastructure for acquiring second hand materials is not yet a reality.

Furthermore, logistics and storage are other elements which make circular transformations a challenging business. Overall, the cases highlighted the need for facilitating policy frameworks that make circular transformations more common and therefore an easier practice. In the cases, preferably reuse and otherwise refurbishing/recycling as much of the former structure and materials as possible was applied. When materials from external sources were added, they tried to use as much from former offices as possible to remain within the circular ambition. Everything that is newly designed should be easily disassembled to enhance promised circularity which makes future reuse considerably easier. The research also highlighted the challenges regarding circularity and sustainability ambitions and how they contradict each other. Providing proper insulation and modern energy installations in an old building will hamper circularity ambitions. Circular practices in the operationalization phase

were done by using a dynamic and open floor plan where mixed use and multiple use of space were ensured. Through this strategy, the space is used more efficiently per square meter, which means less space and thus materials are needed in the end. Sharing the floorspace with others also increases collaboration, innovation, and creativity with an overall better office cohesion. In this way, the office also provides something to the surrounding community by integrating externals.

The research also showed that circular projects tend to have more costs in the beginning than new developments. This can be mitigated by not choosing an expensive ''A-location'', this saves costs in building acquisition and leaves more budget for circular investments. Also developing your own office creates opportunities to arrange lower rental fares with the building manager and gives you the control over which materials are used and where they come from. In this way, construction and operationalization of circular projects can be aligned with circularity and sustainability ambitions. However, the research also illustrated how circularity is merely a part in the process of designing modern office spaces. Sustainability, energy efficiency, inclusiveness, social aspects, and collaboration are also important ambitions to consider when creating a modern work environment. These values should be centred around the end-user of the office, which is the employee. By organizing cocreation sessions, they can provide valuable input to align the future office with their needs and ambitions. Brownfields provide great opportunities and potential when transforming them into offices. Certain challenges will arise, but with an open-minded, creative, and innovative mindset, it is possible to create a responsible and circular working environment for the future.

6.3 Recommendations from the research

This section will contain a step-by-step recommendation strategy which are a summarized result of the lessons learned from the cases and the research in general. It follows the Brownfield project lifecycle framework and regards the planning/ design phase, construction/ renovation phase and operationalization phase.

Planning / design phase

Location choice
As shown in the cases, the choice of location for a new office is one of the first steps in the process and simultaneously one of the most important ones. It can determine eventually how well the working environment is infested in its surroundings and how well it can be accessed by its end user. The following points summarize the main areas to focus on while picking the right location:

- Near mobility hubs as accessibility appeared to be a priority for employees.

- Close range of the city centre.
- Emerging neighbourhoods that are becoming popular.
- No ''A location'' to save acquisition costs and leave investment budget.

Ownership structure
In the cases two different ownership structures were illustrated. Two where the building was managed by a different company, and one where the developer was building owner as well. Especially in the first structure, it is important to closely cooperate with the building owner to ensure sustainability and circularity ambitions are met. The following points show the main recommendations regarding this topic:

- Be in control of your own project by being planner, developer, and end-user.
- If the development will be done externally, ensure materials are circular and durable.
- If you do not own the building, closely cooperate with property manager to shape the same vision and ambitions.

Co-creation
This step has appeared crucial in the planning and design phase of projects that turn Brownfield sites into modern offices. Eventually the employee will have to use the building so designing it according to their needs is crucial in creating a comfortable and healthy working environment. As shown in the cases, this could be achieved by organizing co-creation sessions with the employees. The following points highlight why co-creation is an essential step in the design:

- Ensures the office meets the needs of its employees.
- Fits the identity of the surrounding area and community.
- Thinking out of the box.
- Enhance creativity and innovation.

Overcome challenges
As highlighted in the cases and the theory, several challenges appear when developing Brownfield sites into modern offices. Some challenges regard extra costs, time, and complexity to design and plan such a project. The following points mitigate the challenges mentioned in the cases:

- Arrange lower rent fares with property manager by developing yourself, this saves costs.
- Arrange material depots to efficiently acquire, store and transport second-hand materials.
- Cooperate closely with municipality for building permits, proper business case required.
- Zoning plan procedure should be added by municipality to stimulate circularity considerations.
- Cocreation helps with finding best practices.
- Calculate buffer time in the project in advance so unexpected challenges are easier mitigated.
- Decide on priorities, what the foremost ambition is (sustainability, circularity, energy).

<u>Construction/ renovation phase</u>

Demountable design
Considered a big step that can be executed in advance to ensure the building can be transformed in a circular way in the future. Considering that the building might be transformed in the future and therefore implementing this in the design can mitigate recycling or reusing efforts in the future. See following points that highlight the reasons why a demountable design is beneficial:

- Increase promised circularity by using easily disassembled designs (nails instead of glue).
- Flexible design decreases disassembling costs.
- Flexible design increases user potential (mixed use).

- Flexible design decreases energy consumption in disassembling phase.

Material choice
Ensuring sustainability in the construction and operationalization of a building starts with the choice of materials. It determines aspects such as carbon footprint, energy input, and durability. The following points illustrate the recommendations when deciding on which materials to use:

- Use durable long-lasting materials, initial investment will be higher, but downturn will be better.
- Use locally produced materials to reduce carbon footprint.
- Use materials with low energy input (timber).
- Use second hand materials and minimize use of primary raw materials.

Circularity practices
A core message in this research. It relates to the earlier mentioned theory about the levels of circularity and which practice is preferred over the other. A higher level of circularity means that the energy to do this practice is less and thus the impact on the climate. See following bullet points:

- Prioritize refusing, redesigning, and reusing because circularity levels are higher.
- Refurbishing or recycling when previous practices are not possible.
- Recovering or downscaling as last resort.

Building preservation
An important aspect when dealing with older buildings that might contain historical heritage or even a monumental status. A core concept in Brownfield redevelopment and something that makes these developments worth it compared to new developments. Preserving the old identity of the building in making a new office should always be considered when doing projects like this. See following points that can serve as guidance when considering a Brownfield redevelopment:
Minimize adjustments/ interventions to exterior/ skin of the building.

- Cherish building identity preservation in new design.
- Preserve historical value and heritage.
- Integrate a modern design into the old environment to shape new office identity.

Interior
The interior eventually determines how well the building can operate as a modern working environment and how well the employees can operate in the building. It determines furthermore several aspects such as productivity, creativity, and collaborative capacity of the building. See following points that can serve as guideline when thinking about interior design:

- Reuse amenities from former offices.
- Acquire second-hand objects with minimal usage intensity (closets, partition walls).
- Open floorplan with different functions and sound levels for an optimal work environment.
- Single-floor design enhances cohesion and interaction between colleagues.
- Facilitate multifunctional use of space and mixed use of rooms through a dynamic design.
- Create overcapacity to facilitate office space for externals.
- Centre interior design around the end-user: office employee. Use cocreation input.

Energy
Nowadays a crucial aspect in determining the sustainability of a building and one of the core focus points of companies when deciding on a new location. Energy consumption and efficiency is not only beneficial to operationalization costs but also to its surrounding climate. The first steps in creating an energy efficient building are made in the construction phase. See following recommendations regarding energy in construction:

- Invest in proper insulation.
- Reduce energy consumption in construction by picking the right materials and efficient design.
- Reduce construction waste and loss of energy, all waste should be repurposed.
- Consider energy efficiency in building design, minimize loss of heat.
- Provide space for renewable energy sources (solar panels).

Remediation
This is a challenging but necessary step when considering a Brownfield redevelopment. Especially industrial heritage could contain damaging substances that are not acceptable in a modern working environment. Other substances such as asbestos used to be a common material in the construction of buildings but are now seen as a hazard for human health. One should therefore always consider a thorough remediation analysis to mitigate harmful materials (asbestos, chromium).

Operationalization phase

Collaboration
A crucial aspect in determining a company's efficiency and therefore its success is proper collaboration internally. As seen in the cases, an office's design can determine its collaboration capacity a great deal. The following points are recommendations on how a building's interior can facilitate proper internal collaboration:

- Enhance cohesion by open spaces to improve social interaction.
- Motivate employees to come to the office as it will improve collaboration and innovation.
- Facilitate and motivate cross-pollination amongst employees and externals.
- Improve cooperation, social interaction, creativity, and innovation through active collaboration.

Long term vision
Achieving results in terms of sustainability and circularity are not always direct and might require some patience and a long-term vision. Especially investments made in this sector can be considered quite significant at first when no direct results are perceived. The following tips can help tailor the right strategy for such projects:

- Create a holistic strategy that is durable for the long term where all values are considered.
- Look for a synergy between sustainability and circularity to let them coexist.
- Accept the fact that sustainability and circularity might hamper each other in the process.

Energy
Being efficient in energy use in the operationalization phase follows the previous point about construction. It is one of the main factors in determining the sustainability of a building and thus how well an organization takes its responsibility in the transition to a more circular economy. See the following points how to operationalize an energy efficient building:

- Minimize energy usage by smart cooling/ heating / lighting installations.
- Plan to meet the TENB requirements in the future to have a truly energy neutral office.
- Minimize the loss of energy through waste, recycle and repurpose.
- Only use renewable energy sources and generate them yourself.
- Minimize water consumption in the building.

Share the building
A unique strategy that was highlighted in the cases and appeared considerably effective in dealing with overcapacity but also enhancing an organization's creativity, efficiency, and impact on its

surroundings. Sharing the building with externals also appeared to increase their own employee's productivity. See the following points that explain why one should consider sharing the office with externals:

- Improve cross-pollination with externals.
- Improve interaction with surroundings by getting engaged with the local community.
- Share knowledge with relevant companies and students.
- Open the buildings in the evenings and weekends for externals to enhance space efficiency.

Branding

Something that is in close relation with building preservation and integrating a building's former historical identity is branding the office. By integrating local identity of the community and the building into a modern office design, employees are more drawn to work on location instead of at home as the cases have shown.

Responsibility

In the transition to a more sustainable and circular economy, taking responsibility with yourself is the first step. Companies with a considerable impact should be front runners in taking responsibility for a sustainable future. The following points illustrate how this can be achieved in the operationalization phase of a modern office:

- Use fair-trade and vegan products in the office and canteens.
- Help the community by providing easy work.
- Provide space for training.
- Enhance biodiversity.
- Conserve flora, wildlife and habitats on site and add enough green.
- Consider climate adaptation by adding blue infrastructure and urban drainage.

Mobility

At last, the office location should be easily reachable by its employees. This is a big determinant in office occupancy. If the effort is too significant to reach to office, one might consider working from home instead. The following points can be used as recommendations in ensuring proper mobility:

- Good accessibility for public transport, car, and bicycle use.
- Enough parking spaces for bicycles, electric and normal vehicles.
- Swift access to city centre and walking routes.

6.3 Limitations of the research

Although the research was considerably extensive with many sources of information, data that was analysed and interviews that were taken, certain statements can be questionable. Firstly, the three cases that are discussed happened within the same organisation (RHDHV). The generalizability of the results is therefore questionable because cases in other scenarios, for different companies or other external factors can be perceived in other ways. The external reliability of this research is therefore less significant. The cases provide insight in how other projects could implement circular office transformation in inner-city Brownfields, but it should not be considered as the only possible strategy. This should be considered when reading the recommendations and concluding statements of this research.

The internal validity of the research is questionable as well because the cases are very dependent of each other. Because they are operating within the same vision and strategy of a company, there is a lot of correlation between the cases. To draw conclusion from this correlation is an obvious practice and less scientifically relevant than drawing conclusions from correlation of independent cases. Nevertheless, the cases are unique examples in their own way and should not be seen as identical.

General reliability of the research can be considered sufficient because triangulation has been ensured through the analysis of corporate data, interview data (13 interviews) and theoretical literature. The only questionable aspect are the interviews as the interviewees are mostly from within the same organisation (RHDHV) and have the similar professions. Within the pool of interviewees, project developers, office end-users and investors have been encountered, but not from the governmental corner. So, the people who execute and make policy have not been interviewed.

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Appendices

1. Time planning

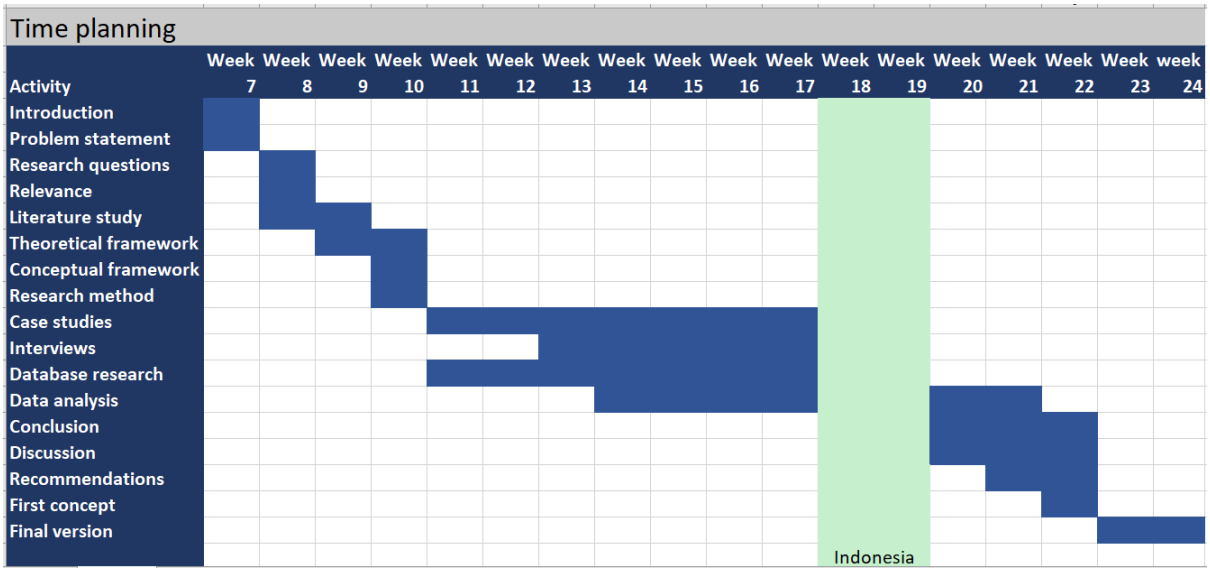

Figure 35: Time planning scheme

2. Interview guide – semi structured interview

Objective – which information would I like to retrieve?

I would like to know how the concept of circularity is manifested in the process of transforming inner-city Brownfield sites into offices. Are they bounded by or supported by policies in the process of implementing circularity or choosing a location (greenfield vs brownfield). What is their experience with Brownfield redevelopment? Do they like it, and do they see a future in it? I would also like to know if they notice a change in office demands and how they adapt the development. How they work together with investors or authorities and neighbouring owners. Do they think about the regeneration of the area?

Introduction

Hello, my name is Rick Hartingsveld and I'm a student in the master Spatial Planning for Land, Planning & Real Estate. I'm currently conducting research for my thesis, and I would like to ask you some questions regarding that topic. It's about the redevelopment of inner-city Brownfield sites into modern offices that meet the needs of post-covid office employees in a circular way. The objective of the research is to find out how the concepts of circularity are manifested in the construction and operationalization phase of the process. The format of the interview is semi-structured, so I have some

predetermined questions, but I would like to encourage you to tell as much as you'd like. So, if you want to tell a story or have specific examples about a certain subject, feel free to share everything. The data gathered from these interviews will serve as my main information source in my research. Are you okay with me using this information and recording this interview? It will be sorely for me so I'm able to transcribe it afterwards.

Warm-up Questions

1. *What is your name?*

……
.

2. *What is your profession?*

……
.

3. *How long have you been doing this work?*

……
.**Location of Brownfield sites**

4. *How do you decide which plot or building will be refurbished into an office (or house)?*

……
.*Possible follow ups:*

- *Is there guidance from the local authorities or do you work together with owners or investors?*
- *Do you look at surrounding amenities or corporate clusters?*
- *Do you consider the vicinity of transport hubs? (For employees or residents)*
- *Are there guiding policies or regulations for picking a Brownfield location?*

5. *How do you see the role of green spaces, such as rooftop gardens and outdoor meeting areas, in the design of modern offices and in creating sustainable, liveable cities?*

……
.

6. *Can you tell me something about possible challenges or opportunities you encounter when redeveloping inner-city Brownfield sites?*

……

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- *What do you prefer, within the existing borders of the city or outside?*

Circularity

7. *What are your thoughts on circular inner-city Brownfield development, and how do you see it contributing to urban revitalization?*

……

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8. *How can the use of circular materials contribute to a closed-loop system, where waste is minimized, and resources are maximized?*

……

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9. *What are some of the economic, environmental, and social benefits of using circular materials in modern offices, particularly in the context of Brownfield development and urban revitalization?*

……

.

10. *Is it efficient to reuse or redesign materials in terms of costs, time, and labour?*

……

.Follow ups:

- *Which materials are easy to reuse?*
- *Which materials do you prefer to reuse?*
- *Which materials in your experience are mostly reused and which materials or parts of a building are almost never reused?*
- *Challenges and benefits?*
- *For which reasons do you decide to use a new material, and do you consider how this material is retrieved?*
- *Are costs a leading factor in choice of material (new materials)?*

Policies

11. *Are there restraining policies or regulations that limit possibilities for Brownfield development?*

……

.

- *For example, forced circularity?*
- *Or limited in the choice of material?*

12. *Are there facilitating policies or regulations that support the development of Brownfield sites?*

……

.

- *Funding frameworks for inner-city development?*
- *Subsidies for sustainable urban development or circularity?*

Office design

13. *Do you currently notice a difference in the design of offices? If yes, please elaborate.*

……

.

14. *What are some innovative technologies or approaches that you think could be used to create sustainable and adaptable workspaces?*

……

15. *Can you share any insights on how circular material use can help to create more adaptable and flexible workspaces that meet the needs of a changing workforce?*

……

.

16. *How can we design modern offices that can accommodate a hybrid workforce, including those who work remotely or have flexible schedules?*

……

.

Cooling down questions

17. *Do you have interesting projects upcoming soon?*

……

.

18. *Do you think my research topic is relevant?*

……

.

19. *How do you see the future of circularity in the building sector and the future of Brownfield redevelopment?*

……

.

20. *Would you like to see the results of my thesis after I've published it?*

……

.

Do you have other points that you would like to share that could be relevant for my research?

……

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