Circular Principles for Real Estate Development: Adjustment for project selection & its application in practice

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Executive Summary

Introduction

This thesis examines how circular principles can be integrated into project selection processes in real estate development, with a focus on transforming existing buildings. The construction sector is responsible for 40% of global resource consumption and a third of CO_2 emissions, necessitating a shift from linear consumption models to circular practices. These principles aim to optimize resource use through reuse, recycling, and closed material loops. Key drivers, such as regulatory frameworks like the EU Taxonomy, economic incentives, and technological tools, promote this transition, while barriers include high initial costs, lack of expertise, and regulatory constraints. The research addresses the central question:

"How can circular principles be integrated into project selection criteria in real estate development?"

Three sub-questions guide this inquiry:

“What are the circular principles that can be applied in real estate development and what are their drivers and barriers?”

“What are the selection criteria for projects for real estate development?”

“How can a framework for project developers integrate circular principles in the process of selecting real estate development projects?”

The study combines a review of previous studies, expert interviews, and a focus group to explore these questions, offering actionable insights for advancing circular practices in real estate.

Literature Study

Circular principles emphasize minimizing waste and maximizing material value across the building lifecycle. Tools such as Life Cycle Analysis (LCA) and Building Information Modeling (BIM) enable developers to assess environmental and financial impacts. Regulatory frameworks, like the EU Taxonomy, and technological advancements, such as material passports, drive circularity adoption. However, barriers persist, including high costs, rigid regulations, and the complexity of reusing building components.

Project selection processes traditionally prioritize profitability and resource optimization but often overlook circularity. Frameworks like the two-stage filtering approach by Pekuri et al. (2015) and front-end management methods emphasize early decision-making but lack alignment with circularity goals. Integrating tools like Life Cycle Analysis (LCA) and fostering interdisciplinary collaboration can bridge this gap. By demonstrating long-term economic benefits and leveraging subsidies, developers can balance sustainability with economic feasibility.

Preparation and Methodology for Empirical Study

The research adopts a two-phase methodology to investigate the integration of circular principles in the German real estate sector.

Phase 1: Semi-structured interviews with nine experts explored current practices, challenges, and opportunities in circular project selection. Themes such as economic feasibility, project evaluation, and stakeholder dynamics were analyzed using thematic coding in ATLAS.ti software.

Phase 2: A focus group with seven professionals validated and refined recommendations from Phase 1. Participants evaluated the relevance and feasibility of proposed strategies, leading to further insights and refinements.

Triangulation of literature, interview data, and focus group findings identified actionable recommendations, bridging theoretical concepts with practical applications.

Findings

Five themes emerged from the empirical study: economic feasibility, project analysis, people and knowledge, technology and innovation, and external factors. Key findings include:

- The importance of Life Circle Analysis (LCA) and material passports for assessing reuse potential and long-term impacts.
- The early integration of circular principles into project planning to maximize feasibility.
- The role of expert knowledge, facilitated by external consultants and internal training, in overcoming knowledge gaps.
- Barriers such as high costs, administrative complexity, and limited financial incentives.

To ensure practical application, the findings have been synthesized into a visual roadmap that aligns recommendations with different stages of the project selection process. This roadmap categorizes recommendations by their relevance and feasibility, providing a clear and structured guide for project developers to effectively integrate circular principles into real estate development. The roadmap can be found in Figure 1.

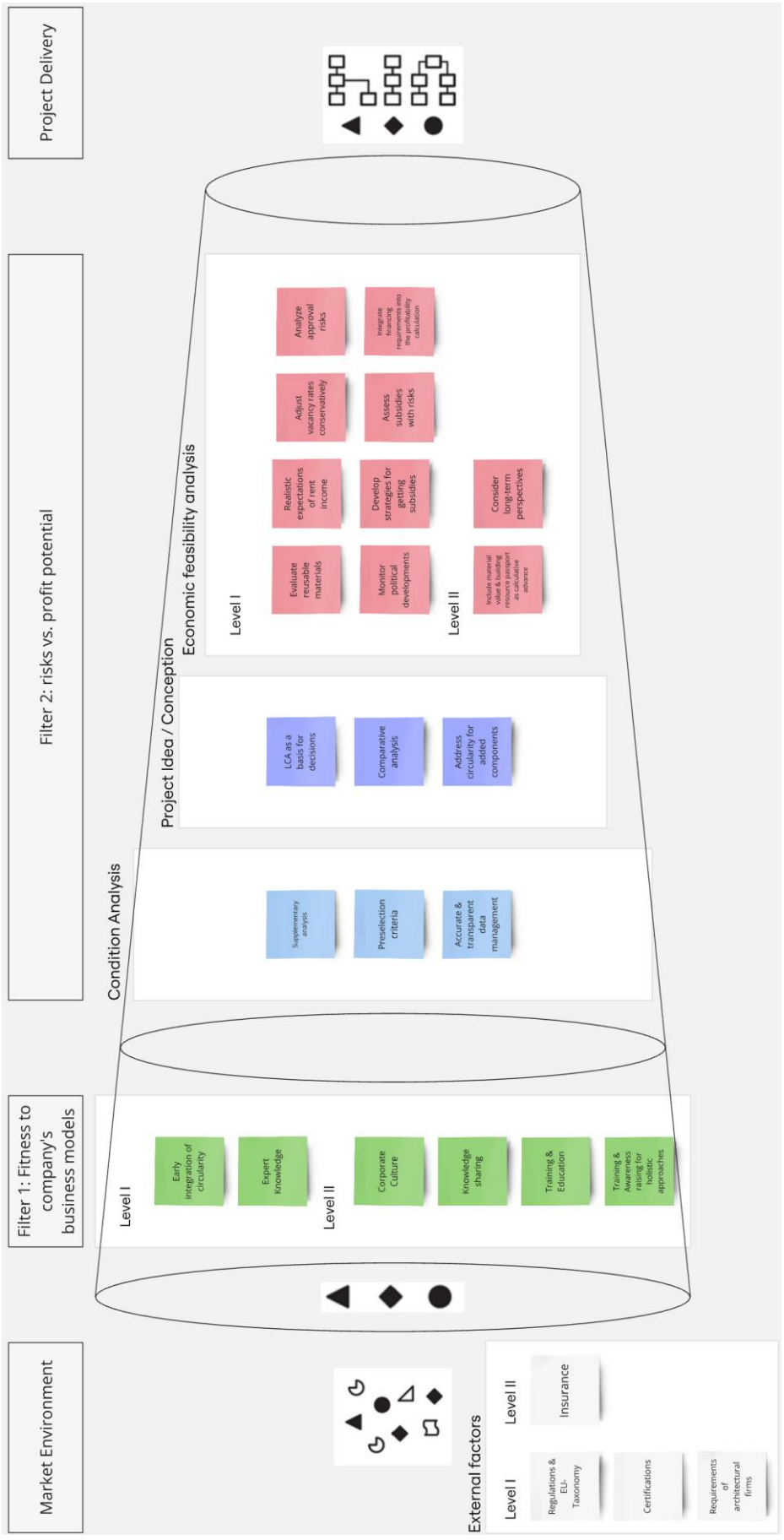

Figure 1: Roadmap for integrating circularity into project selection criteria

Discussion and Recommendations

The study reinforces the industry's reliance on traditional metrics like cost and time, which often overshadow circularity. This tendency aligns with Pfnür and Wagner's (2020) findings on the Iron Triangle's dominance. Addressing these priorities requires a shift in corporate culture and greater awareness of the long-term benefits of circularity.

Drivers such as material passports and digital tools were highlighted as crucial for enabling transparency and standardization, echoing suggestions by Hebel and Heisel (2022). Barriers, including regulatory rigidity and inconsistent metrics, remain significant challenges, as noted by Munaro and Tavares (2023).

Practical recommendations emphasize early integration of circularity, supported by tools like Life Circle Analysis (LCA) and collaboration with external experts. Stakeholder alignment is essential, particularly in addressing demands from investors, regulators, and tenants. Corporate culture plays a pivotal role in ensuring that circular principles are embedded into organizational strategies, not just individual projects.

The roadmap developed in this study offers a structured framework for integrating circular principles into real estate project selection. By addressing economic, environmental, and social objectives, this approach ensures sustainable development while aligning with industry needs and regulatory requirements.

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1. Introduction

This chapter serves as a basic introduction and provides a clear overview of the topics and objectives covered in this master's thesis. First, the section 1.1 Background provides an overview of previous research and explains why the circular economy is becoming increasingly important in the construction industry. The chapter 1.2 Problem definition outlines the specific research gap of this thesis. In 1.3 the research objective and scope are defined. The chapter 1.3.2 includes the research questions. Chapter 1.4 provides a clear orientation for the analysis and defines the framework for the methodology and structure of the work.

1.1 Background

The construction industry makes a significant contribution to economic growth and social development. It creates jobs, drives innovation and provides the infrastructure that is essential for both everyday life and economic progress. Buildings, roads and supply infrastructure make functioning cities possible and support a growing population. Through construction projects, the industry promotes quality of life and plays a key role in the development of modern and sustainable living and working environments (Eisele et al., 2020). But there is also a downside, since the construction industry is one of the largest consumers of resources worldwide and contributes significantly to global environmental problems. It consumes around 40% of global resources and is responsible for around a third of anthropogenic CO_2 emissions and 40% of global waste (Gebetsroither et al., 2024). The construction industry often works inefficiently and wastefully. For example, around 10-15% of building materials are wasted during the construction phase and existing buildings could save 20-40% of energy, while more than half of demolition materials end up in landfills (Ellen MacArthur Foundation, 2015).

In addition to environmental problems, the construction industry also faces economic challenges (Eisele et al., 2020). A study by Young et al. (2023) shows that by the end of this century, 78% of European office buildings will be at risk of obsolescence due to their age and inadequate quality of fit-out. These buildings no longer meet current requirements and must either be modernized or repurposed to remain economically viable. Additionally, future office buildings will need to be redesigned, as currently 60% of office space in Europe remains unused even during working hours, requiring flexible and more efficient use of space (Ellen MacArthur Foundation, 2015). By transforming and reusing these existing structures, they can be made usable again, which not only saves resources, but also preserves the CO_2 already captured in the buildings and thus avoids significant CO_2 emissions (Eisele et al., 2020).

To address these challenges, a transition to circular economic models that promote recycling, reuse and innovative construction practices is needed, which can contribute to a sustainable environment and society (Benachio et al., 2020). There are several politically and economically driven initiatives and projects that aim to promote sustainability and circularity in the construction industry, like the Paris Agreement from 2015, the European Green Deal from 2019 or the EU-Taxonomy. These movements are often driven by international agreements and regional strategies that set concrete measures and frameworks to support sustainable construction (Gebetsroither et al., 2024). Political measures such as international climate agreements oblige countries to reduce their CO_2 emissions and implement more environmentally friendly practices. Economic incentives and regulations motivate companies to use sustainable technologies and materials that reduce waste and minimize resource consumption (Bize, 2024).

The problem with the current practices of the construction industry is their predominant use of linear consumption of resources. In this model, raw materials such as sand, gravel, wood and metals are extracted, processed, utilized and disposed of without being reused or recycled. The extraction of raw materials causes significant CO_2 emissions. The processing of building materials

is energy-intensive and further contributes to global warming. Inefficient construction practices lead to material waste and additional emissions. Energy and water are continuously consumed during the use of buildings, and many are not energy efficient. During maintenance and renovation, new materials are often used instead of recycling existing ones. At the end of a building's life, construction and demolition waste is produced, most of which ends up in landfill or is incinerated, leading to further pollution and loss of valuable resources (Munaro et al., 2020). Linear consumption also has social and economic consequences, including negative effects on health and quality of life in raw material extraction areas as well as rising costs for raw materials and disposal in the long term (Hebel & Heisel, 2022).

The circular economy can be described as an economic model that aims to keep resources in circulation for as long as possible, minimize waste and reduce environmental impact (Benachio et al., 2020). Instead of extracting raw materials, using them and then disposing of them, the circular economy preserves the value of materials and products for as long as possible. This is done through reuse, repair, refurbishment and recycling (Aigwi et al., 2023). In the construction industry, circular economy means that buildings and materials are designed, constructed, utilized and treated at the end of their life cycle in such a way that they can be reused or recycled (Benachio et al., 2020). Figure 2 shows the systemic focus areas that are important for the transformation into a more circular economy in Europe. The diagram highlights key touchpoints along the product value chain and places particular emphasis on extending the lifespan of products. The largest circle in the diagram, which addresses the topic of “longer and better use of products”, illustrates that topics such as the transformation of existing buildings can make a significant contribution to circularity by preserving and continuing to use existing structures (Bize, 2024). The transformation of existing buildings offers significant economic, environmental, and social benefits, as it can potentially enhance urban resilience, reduce costs, increase political acceptance, align with ESG (Environmental, Social, Government) goals, and diversify financial risk. Leveraging existing structures can lower material costs, speed up implementation, and attract public incentives, improving financial viability. Politically, early stakeholder engagement boosts acceptance and can streamline approvals (Waldburg et al., 2022).

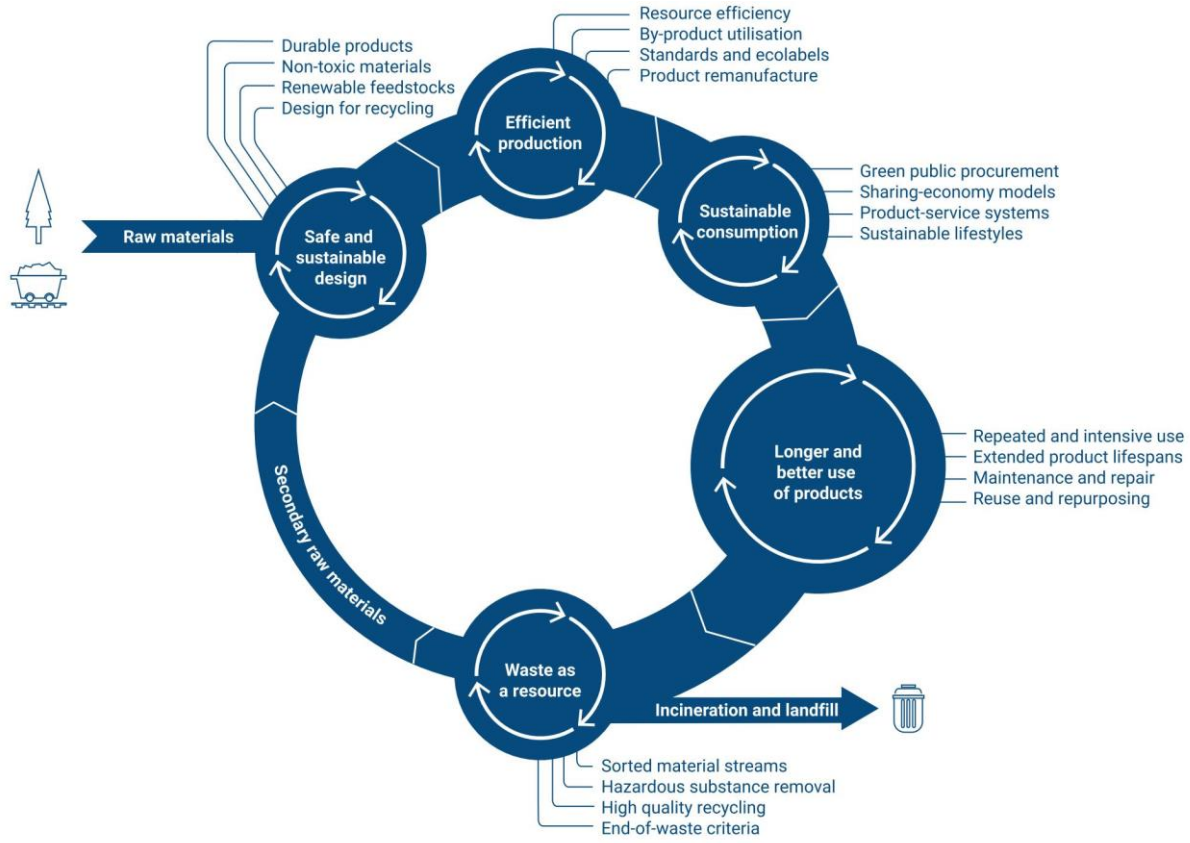

Figure 2: The touchpoints for achieving a circular economy in Europe
Source: (Bize, 2024, p. 11)

Since the 1970s, when project management was first being studied, the Iron Triangle - also known as the Triple Constraint (time, cost and quality/scope) - has been a key component of the discipline. The criteria of being on time, within budget, and to a defined quality continue to hold a dominant position in the understanding of whether a project has been delivered as planned, despite a significant body of research arguing that the Iron Triangle does not adequately capture the story of project success measurement (Pollack et al., 2018). In this context, the integration of the Triple Bottom Line of sustainability (environment, society, and economy) is becoming increasingly important. Circularity should be incorporated as a central element in the project development process. This connection creates a framework to integrate circular principles into real estate projects and ensure the long-term success of projects (Ebbesen & Hope, 2013).

Project developers play a key role in this process of adapting the practices of real estate development. They coordinate the entire development process - from developing a plan and assessing financial feasibility to negotiating with local authorities and procuring construction and consultancy services. In the process, project developers make decisions that significantly influence the success and the level of circularity of a project, such as the choice of technologies and materials (Meijer & Buitelaar, 2023). Front-end management is the early stage where the crucial foundations for later project success are laid. The decisions made in this phase have long-term impacts on the construction, operational, and disposal costs of a building (Edkins et al., 2013). The opportunities to influence costs, especially the costs during the operation phase, are greatest at the beginning of a construction project. With advancing planning, this influence rapidly decreases, which is why the integration of circular principles, and the life cycle approach is particularly important at this stage. By incorporating circular economy principles early in front-end management, a building can be designed not only more cost-efficiently but also more circular throughout its entire lifecycle (Friedrichsen, 2024).

1.2 Problem definition

In recent years, the global pressure on project developers to implement circular practices in real estate development has increased significantly. Studies in the field of front-end management show the crucial importance of early decisions on project success, which underlines the relevance of project selection methods for the organizational success of project developers (Olsson & Samset, 2006). However, despite this importance, circular economy principles are often insufficiently considered in these selection methods (Eisele et al., 2020).

The reasons for this are manifold: high costs, lack of knowledge, lack of standards and the complexity of the projects (Munaro & Tavares, 2023). Although circular construction projects should be promising in terms of sustainability, these approaches do not always lead to the desired success in practice. This is often because the standard project selection methods are not sufficiently adapted to the principles of the circular economy (Eisele et al., 2020; Misnan et al., 2024). There is a lot of research on project selection methods in academic research, however, the focus is often not on the success of companies, instead the priority lays on aspects like technical efficiency, environmental impact or social and policy alignment (Misnan et al., 2024). However, it is precisely this link between selection methods and business objectives that is crucial for the successful implementation of construction projects and the long-term competitiveness of project developers (Pfnür & Wagner, 2020). This gap in research has practical consequences for the construction industry and the circular economy, as unsuccessful project selection hinders sustainable success in the long term. Research also shows that the business models of companies in the construction industry are not sufficiently adapted to circular construction practices (Pfnür & Wagner, 2020; Williams & Dair, 2007; Zhang et al., 2009). This leads to such practices being applied only on a project-specific basis, if at all, and not integrated into the corporate strategy (Pfnür & Wagner, 2020).

Despite the growing awareness of circular construction projects and their potential, studies such as those by Cottafava and Ritzen (2021) show that in practice, there is a lack of clear indicators and methods for assessing circularity. Most indicators focus on aspects such as the use of primary materials, the amount of non-recyclable waste, and the lifespan of products. A holistic method that represents circularity at the macro level (materials), the meso level (supply chain), and the micro level (design) has not yet been fully developed (Cottafava & Ritzen, 2021). Furthermore, research shows that despite the recognized potential for circular transformations, the selection of the right projects often fails due to a lack of criteria (Hoogendijk & Bolt, 2020). Failed construction projects, such as the conversion of office buildings into residential spaces, where the quality of life for residents is compromised due to structural issues (e.g., noise and temperature problems), highlight the necessity of careful project selection (Centraal Bureau voor de Statistiek, 2023). An integrative evaluation that includes circular criteria could prevent such deficiencies and ensure the success of circular construction projects (Hoogendijk & Bolt, 2020). There are indeed a variety of practices and approaches that support the circular economy in project development, but there is a lack of project-specific conditions that ensure these can be successfully implemented. Benachio et al. (2020) emphasize that the circular economy in the construction industry is often viewed only as a global vision, while the specific conditions of individual projects are neglected.

The problem can be summarized as follows: *There is a lack of clearly defined, project-specific conditions for the successful implementation of circular principles in real estate development projects, as existing methods for project selection inadequately consider circular economy aspects*.

The aim of this master's thesis is to identify these conditions and thereby improve decision-making in project development.

1.3 Research objective & Research questions

1.3.1 Research objective

The focus of this master's thesis is to investigate how circular principles can be successfully integrated into project selection processes, particularly in relation to the transformation of existing buildings. Two concepts play a central role here:

Standardized methods for project selection: These methods support project developers in identifying suitable areas or properties during the acquisition process. They provide an important basis for project selection, but rarely take circular principles into account (Misnan et al., 2024).

Circular economy principles: These include approaches of the circular economy, which enable the circular transformation of existing buildings. However, there is a lack of clear standards and incentives to integrate these principles into project selection processes (Munaro & Tavares, 2023).

It is necessary to link the two concepts - standardized methods for project selection and the principles of the circular economy - to enable a successful selection process for circular construction projects. By expanding project selection methods to include criteria of the circular economy, a better project selection could be made and the successful implementation of circular economy goals in practice could be ensured. The aim of this thesis is to provide the field of real estate development with a sound basis for the selection of projects that optimally integrate circular principles.

1.3.2 Research questions

In this section, the problem statement and research objectives are translated into a main research question and related sub-questions.

Main research Question:

RQ: How can circular principles be integrated into project selection criteria in real estate development?

Sub-questions:

RQ 1: What are the circular principles that can be applied in real estate development and what are their drivers and barriers?

RQ 2: What are the selection criteria for projects for real estate development?

RQ 3: How can a framework for project developers integrate circular principles in the process of selecting real estate development projects?

1.3.3 Research scope

This work focuses on the selection process of projects for circular building transformations. This encompasses the circular economy approach, in which existing buildings are converted and reused in the interests of sustainable use. This form of transformation makes it possible to extend the life cycle of buildings, conserve resources and at the same time minimize the need for new buildings. This work focuses on the life cycle phases of buildings, in particular the transition from the end-of-life phase of a building to project planning (Eisele et al., 2020). This is where front-end

management comes into play, as important decisions are made in these early phases of project development that have a significant impact on the subsequent success of the project (Edkins et al., 2013).

The German market holds a pivotal role in this research due to its significance and dynamism within the European construction sector. With an investment volume of €486.8 billion - almost 40% more than France, the next largest market - Germany boasts one of the most active and influential construction markets in Europe (Statista, 2024). The according numbers and other European countries can be found in Figure 3. The high level of investment by Germany demonstrates not only a willingness to innovate but also an opportunity to advance sustainable building practices, including transformative projects that adapt existing structures for new uses (Eisele et al., 2020). Germany is also at the forefront of building transformation due to its significant stock of underutilized office and commercial spaces. By 2022, more than 3.18 million m^2 of rental space had been converted into transformative projects, showcasing the country's extensive experience and practical expertise in this area (Waldburg et al., 2022). Notably, over 50% of these successful transformations involved former office buildings being converted into mixed-use spaces, incorporating living, working, retail, and leisure. This highlights Germany's ability to repurpose underutilized office spaces into multifunctional buildings that meet contemporary urban demands. This momentum aligns with broader trends and pressing needs in the German real estate market. For example, approximately 24 million m^2 of office space currently stand vacant in Germany, compared to just 2.95 million m^2 in the Netherlands (Hoogendijk & Bolt, 2020). Even more strikingly, around 75 million m^2 of German office space - roughly 55% of the national stock - are at risk of becoming "stranded assets." This term refers to buildings that will lose their economic viability without substantial investments to modernize or repurpose them. The potential for transforming these stranded assets is immense. Studies estimate that between 15 and 20 million m^2 of these spaces could be converted into residential use, creating 170,000 to 200,000 new apartments. This shift would not only address the severe housing shortage in major German cities and urban areas but also contribute significantly to climate goals by saving an estimated 4.2 million tons of CO_2 emissions (Colliers et al., 2024). The combination of high investment capacity, extensive vacant or underperforming office stock, and the growing focus on sustainability positions Germany as a leading market for innovative building transformations and circular economy practices.

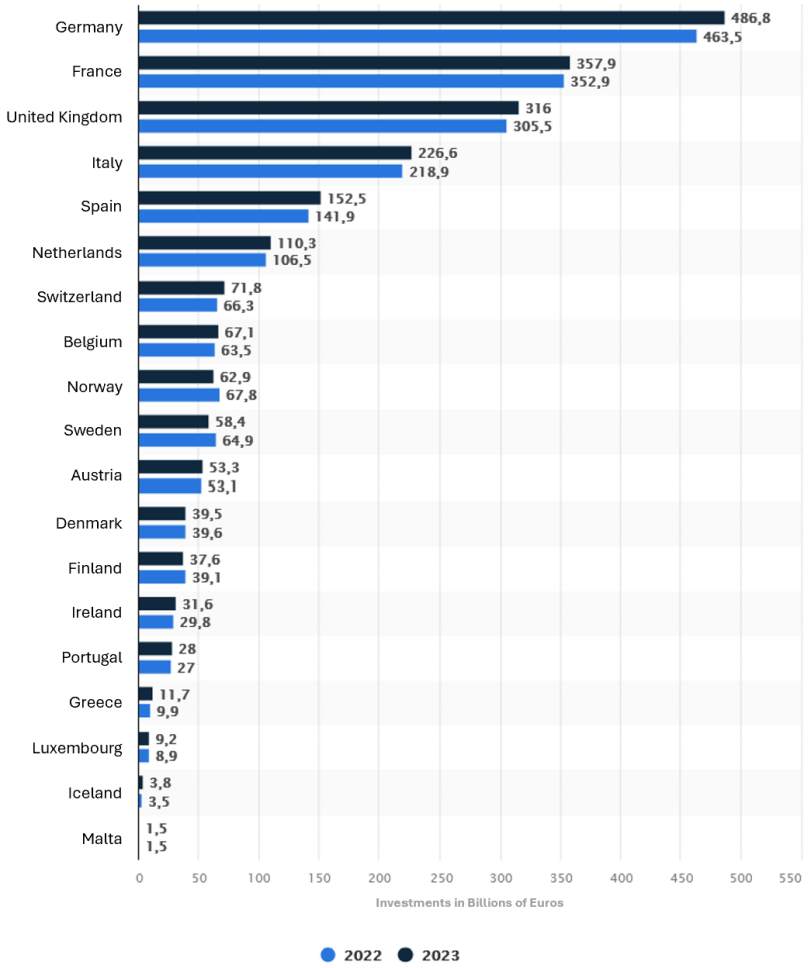

Figure 3: Construction investment in EU countries 2022 and 2023 (in billion euros)
Source: (Statista, 2024, author's translation)

The main actors this thesis focuses on are project developers. They are key players in this process. They guide construction projects through a large part of their life cycle and make crucial decisions, such as which projects should be initiated, or which technologies or materials should be used. While public institutions and regulatory authorities, such as building authorities, often play a more passive role by setting rules and regulations and reviewing or rejecting building applications, project developers have a direct influence on the design and realization of real estate development projects (Misnan et al., 2024). This thesis is aimed in particular at medium-sized to large companies that focus on the development of large-scale real estate projects in Germany with several stories and an area of more than 15,000 m^2. Medium-sized companies are those with 50 to 249 employees, with an annual turnover of more than €10M or total value of assets on balance sheet higher than €10M. Businesses are considered to be large if they employ more than 250 people, generate more than €50 million in revenue annually, or have more than €43 million in assets on their balance sheet (Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2024).

1.3.4 Relevance of Research

The relevance of this research can be emphasized on three levels: the practical, the social and the academic level, while at the same time addressing an existing research gap.

On a practical level, this work provides crucial support for project developers. By identifying project-specific conditions that are necessary for the success of circular building transformations, the research provides concrete decision-making aids. There is currently a lack

of clear, practical criteria that facilitate the selection of suitable buildings for circular transformations. This work aims to close this gap by linking standardized methods for project evaluation with the principles of the circular economy. This will enable developers to make informed decisions to realize resource-efficient and economically viable projects.

At a societal level, the findings of this work can help policy makers to adapt the building permit process and design effective subsidy programs that incentivize companies to adopt circular building practices. This could lead to a more targeted allocation of subsidies, favoring projects that have the greatest positive environmental impact. Such incentives not only contribute to the spread of circular building practices but also maximize the efficiency of government subsidies and help to achieve climate targets. Social acceptance of such subsidies is also strengthened by the long-term environmental and economic benefits, as circular building transformations not only reduce the carbon footprint but also utilize the housing stock in a more efficient and environmentally friendly way.

On an academic level, this research fills a significant gap in the existing literature of circular economy in the construction industry. Although the circular economy in construction is often considered at a macro level as an overarching vision, detailed studies focusing on project-specific conditions are lacking. The research contributes to closing this gap by investigating which factors favor the implementation of circular transformations in individual projects. Linking theory and practice creates a valuable contribution that not only advances existing models but also serves as a basis for future research that deepens circularity in property development and transformation.

1.4 Research Design

This chapter gives an overview of the methodologies used for the answering of the research question.

1.4.1 Sub-research Question 1

The first sub-research question will identify the state-of-the-art and relevant application of circular practices in real estate development (see Figure 4). A traditional review of previous studies is used to identify the definition, practices, barriers and drivers for circularity in the construction industry. Because it offers a comprehensive understanding of circularity that has already been studied in academia, this approach answers this sub-research issue. Moreover, since this sub-research question seeks to build a foundational understanding, conducting a review of prior studies is the most suitable method.

For the review of previous studies, a variety of academic databases such Google Scholar, Science Direct, and Research Gate were used. Specific keywords like "project development," "circular principles," “circular building transformation," etc. were used to focus the search. Peer-reviewed academic journals were given priority to ensure the reliability and validity of the sources. This literature review's methodology was developed with the goal of detecting gaps in the existing body of research as well as established hypotheses. As a result, this method establishes the foundation for the empirical research stage.

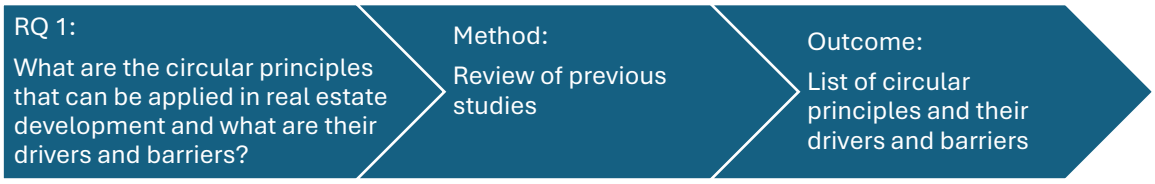

Figure 4: Flow of sub-research question 1

1.4.2 Sub-research Question 2

The second sub-research question will identify the current methods used for project selection in real estate development (see Figure 5). A traditional review of previous studies is used to identify and overview of current practices use in the construction industry, using the same academic databases as mentioned before, adding keywords like “project selection methods” or “project acquisition.”

This step was followed by a round of semi-structured interviews with several real estate developers in the German market. Because it is ideal for an exploratory approach to comprehending the current practices in Germany, the semi-structured interview method was selected. Nine in-depth, semi-structured interviews with experts were conducted to understand the general state of project selection techniques in Germany.

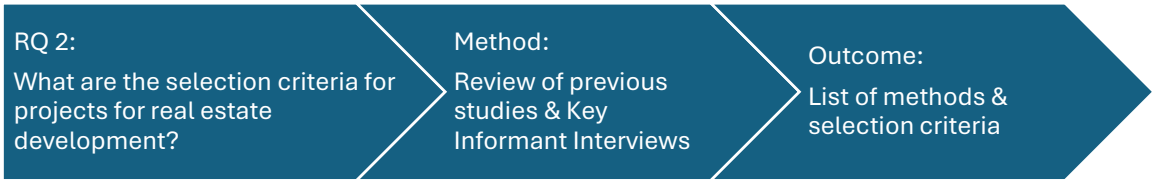

Figure 5: Flow of sub-research question 2

1.4.3 Sub-research Question 3

The third sub-research question reveals possibilities for application strategies to integrate circular principles in project selection processes (see Figure 6). The question was conducted by a round of semi-structured interviews with several real estate developers, as explained in 1.4.2.

This step was followed by a validation by conducting a focus group workshop with 7 professionals in the real estate industry, providing feedback to the strategies that were compiled using interview data.

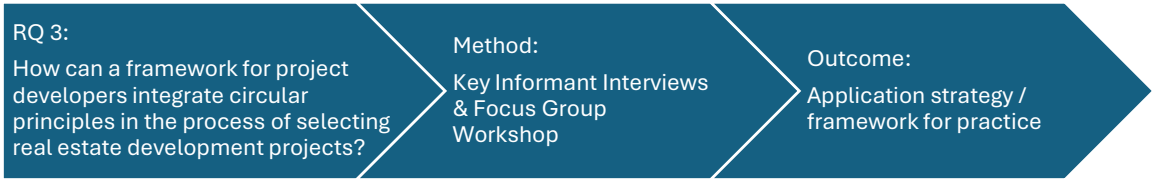

Figure 6: Flow of sub-research question 3

1.4.4 Main Research Question

Using the sub-research questions offers a way to answer the main research question, which addressed the integration of circular principles in the selection process of real estate development. In conclusion, the following workflow illustrates the flow of research data in accordance with the subsidiary research questions.

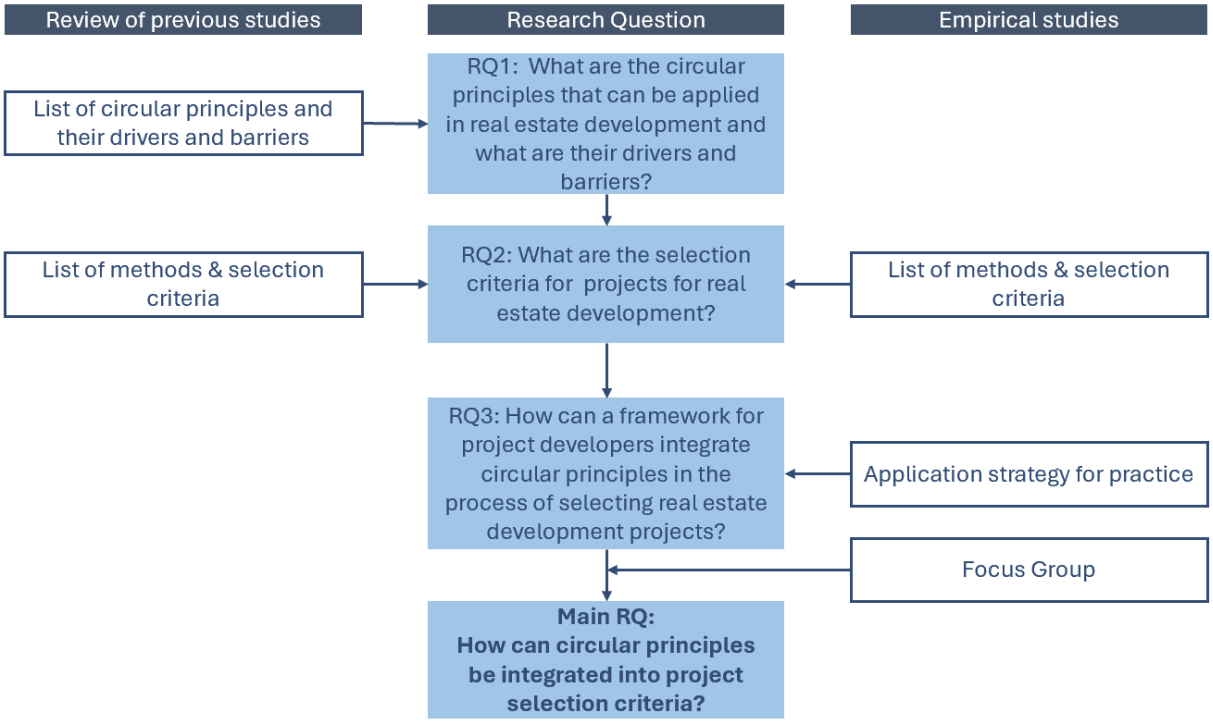

Figure 7: Schematic flow of research questions

2. Literature study

Chapter 2 provides a comprehensive literature review, exploring the foundations and methods for integrating circular principles into real estate development. Section 2.1 introduces the core concepts and applications of circular principles. Subsection 2.1.1 defines the circular economy in the construction sector, while subsection 2.1.1 addresses its specific drivers and 2.1.3 examines barriers that influence the implementation of circular economy practices within the construction industry. Finally, Subsection 2.1.4 introduces the concept of "Circular Building Transformation," highlighting the approach to transforming existing buildings in alignment with circular principles.

Section 2.2 focuses on project selection methods. Subsection 2.2.1 introduces the front-end management. Following this, Subsection 2.2.2 details project selection process of construction projects.

The chapter closes with subchapter 2.3, where the findings of both literature studies are connected, and hypothesis are built.

This structure establishes the theoretical and methodological basis that will later contribute to the development of a framework for integrating circular principles into the project selection process.

2.1 Circular principles

The aim of this chapter is to answer the sub-research question RQ1: “What are the circular principles that can be applied in real estate development and what are their drivers and barriers?” It introduces the circular economy in the real estate sector in chapter 2.1.1. The existing drivers that have been developed to overcome these obstacles can be found in chapter 2.1.2, while the barriers are addressed in chapter 2.1.3. Since the focus of this thesis is the circular transformation of buildings, chapter 2.1.4 explains its principles and offers a definition.

2.1.1 Circular Economy in the construction sector

The circular economy has become a central concept in various industries, including the construction industry (Aigwi et al., 2023). According to the Ellen MacArthur Foundation (2015), the circular economy is a ‘restorative design’ that aims to keep products, components and materials at their highest use value for as long as possible, distinguishing between technical and biological cycles, which is illustrated in Figure 8. This approach distinguishes between two cycles: the technical cycle, in which materials are reused, refurbished or recycled in order to maintain their maximum usability, and the biological cycle, which relies on the regeneration of natural resources (Ellen MacArthur Foundation, 2015). The circular economy thus represents an alternative to the traditional linear economic model of “take, produce, dispose”. It promotes the reduction of resource consumption, the reuse of materials and the recycling of products in order to minimize the impact on the environment while ensuring economic efficiency (Charef et al., 2021).

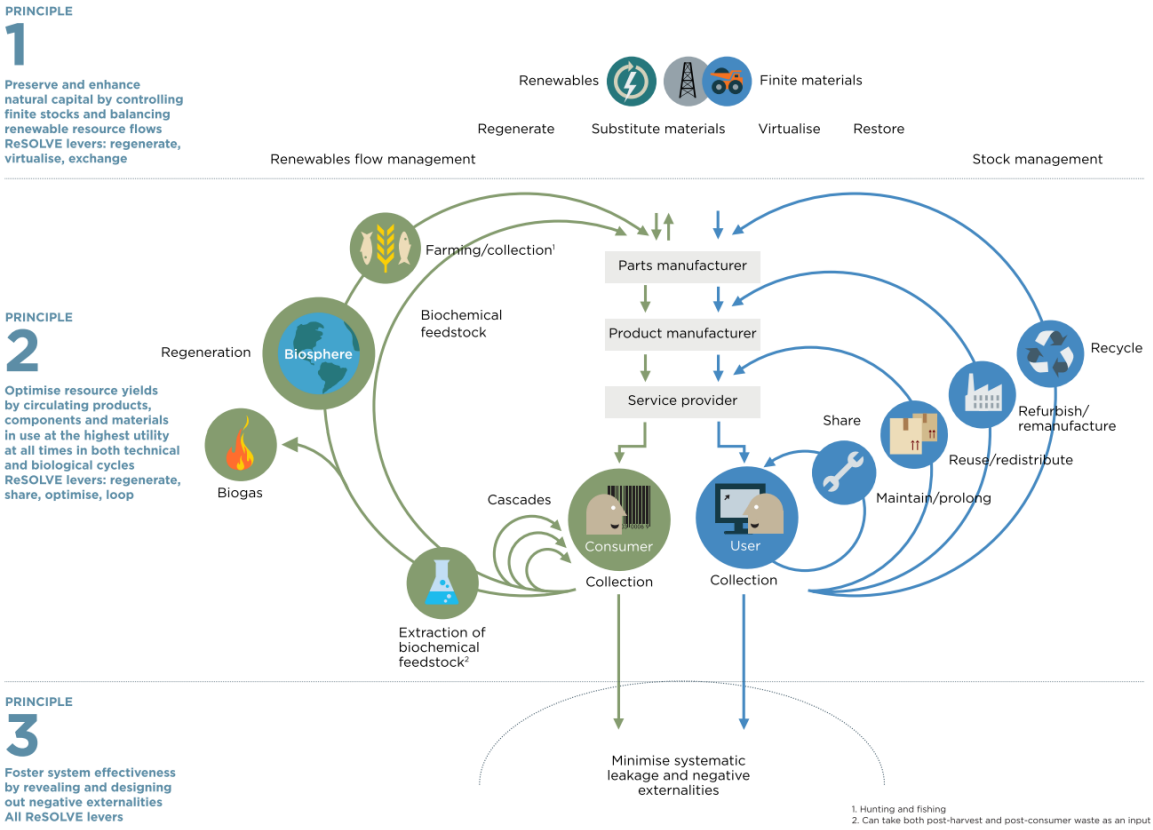

Figure 8: Outline of a circular economy
Source: (Ellen MacArthur Foundation, 2015, p. 24)

The three main principles of the circular economy are reduce, reuse and recycle (Aigwi et al., 2023). In addition to the classic principles of the circular economy, the literature describes other innovative approaches that promote the transition to a circular economy:

- **Regenerate**: promoting the use of renewable energy and materials. This includes the recovery of biological resources to reintroduce them into the biosphere, as well as the restoration and conservation of ecosystems (Ellen MacArthur Foundation, 2015; Peiris et al., 2023).
- **Share**: Shared use of resources and products (Ellen MacArthur Foundation, 2015). This includes the reuse of goods (e.g. cars, rooms, appliances) and focuses on design approaches that promote longevity, upgradability and easy maintenance (Eisele et al., 2020; Hamida et al., 2023).
- **Optimize**: Increasing efficiency by minimizing material waste (Viola & Diano, 2019), improving product performance and using modern technologies such as big data and automation (Peiris et al., 2023).
- **Loop**: Creating closed loops by reprocessing and recycling products and materials and recovering biochemical resources from organic waste (Leal Filho et al., 2023).
- **Virtualize**: Replacing physical products and services with digital solutions, for example in e-commerce, digital media or services such as cloud computing and autonomous vehicles (Ellen MacArthur Foundation, 2015; Peiris et al., 2023).
- **Exchange**: Replacing non-renewable materials and old technologies with advanced materials or new technologies such as 3D printing (Hebel & Heisel, 2022).

These principles provide a general basis for the circular economy and its application in different sectors to support the transition to more circular production and consumption processes.

The circular economy in construction can be defined as follows: “the use of practices, in all stages of the life cycle of a building, to keep the materials as long as possible in a closed loop, to reduce the use of new natural resources in a construction project” (Benachio et al., 2020, p. 5). This definition focuses on the construction industry and emphasizes the use of materials in all life cycle phases of buildings. To illustrate the concepts of the circular economy in the context of construction, Figure 9 provides an overview of the three main types of economy in construction: linear economy, recycling & reuse economy and circular economy. This illustration shows how the circular economy aims to reuse materials and minimize waste and the use of virgin resources in construction (Charef et al., 2021).

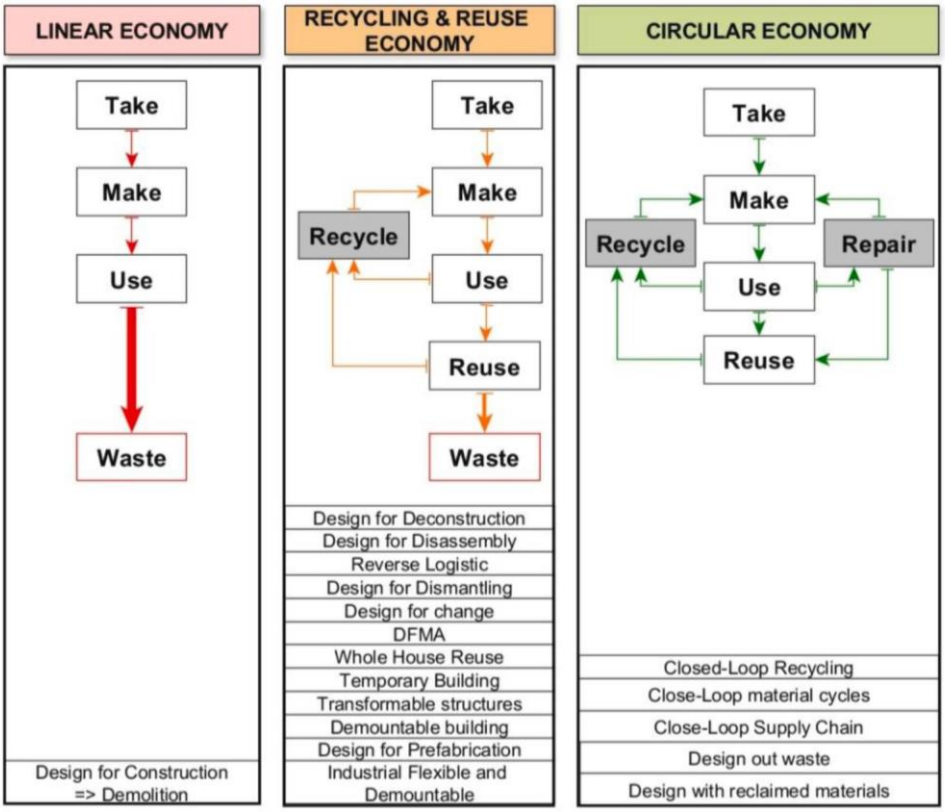

Figure 9: types of economy in the construction industry
Source: (Charef et al., 2021, p. 7)

Adding onto the theory of Figure 9, in the construction industry, circular economy principles can be implemented along the life cycle phases of a building to use resources efficiently and minimize environmental impact. These phases - from design and manufacture, through construction and operation, to end of life - form the foundation for the systematic application of circular principles in real estate development (Bragadin et al., 2023). There are specific approaches at each stage that help to reuse materials and reduce waste (Akhimien et al., 2021; Benachio et al., 2020).

The **project design phase** focuses on aspects such as the design of modular buildings and the adaptability of existing buildings (Aigwi et al., 2023; Hamida et al., 2023). This includes designing for disassembly, which ensures that components can be easily dismantled and reused at the end of their service life (Benachio et al., 2020; Cottafava & Ritzen, 2021). In addition, BIM (Building Information Modelling) models and life cycle analysis are used to assess the reuse potential of materials early in the project (Peiris et al., 2023). A life cycle analysis can show the advantage of using certain materials several times, and material databases help to reuse materials efficiently in new buildings. Scales for analyzing the degree of implementation of circular economy practices

in companies also support the evaluation and implementation of these principles (Akhimien et al., 2021; Benachio et al., 2020).

In the **manufacture phase**, the use of materials is optimized by designing and organizing materials so that they can be reused in a different context after their initial useful life (Akhimien et al., 2021; Viola & Diano, 2019). This can be documented by material passports, which provide detailed information on the reuse and recycling of building materials (Hebel & Heisel, 2022). The integration of secondary materials - i.e. materials that have already been used - into production helps to minimize dependence on primary resources and reduce waste (Benachio et al., 2020).

During the **construction phase**, the reuse of building materials is a key issue. The use of existing materials in new buildings and the implementation of off-site construction (i.e. prefabrication of components at other locations) not only reduces material waste, but also lowers the ecological footprint of the construction project (Benachio et al., 2020). Measures to reduce waste also contribute to the efficiency of the construction processes (Viola & Diano, 2019).

In the **operation phase**, care is taken to continuously assess the condition of the building materials in order to make optimum use of them throughout the building's service life (Bragadin et al., 2023). Tools for assessing the condition of materials and the end of a building's life cycle help to maximize the efficiency and durability of materials (Zimmermann et al., 2023). In addition, water management practices and preventive maintenance measures are applied to minimize the need for reparative maintenance and thus reduce resource consumption (Benachio et al., 2020).

At the **end of a building's life cycle**, it can be analyzed whether existing materials are suitable for reuse or recycling. Dismantling and waste management are key aspects in this phase to ensure that valuable resources are not lost (Benachio et al., 2020). Circularity tools are used to find the best possible solutions for the refurbishment and deconstruction of existing buildings (Cottafava & Ritzen, 2021). The systematic deconstruction of buildings makes it possible to reuse or recycle components and materials instead of disposing of them (Akhimien et al., 2021).

By structuring practices along this life cycle, it becomes possible to take targeted measures at each stage to introduce circularity into practice (Akhimien et al., 2021). The approach ensures that all phases of a building's life cycle are considered to ensure holistic and circular development (Benachio et al., 2020). In the further course of this master's thesis, the focus is on the transformation of existing properties. This process starts at the end-of-life phase of a building and initiates a new design phase, whereby all subsequent life cycle phases are run through again. Through this approach, the principles of the circular economy can be applied comprehensively: from the reuse and adaptation of existing materials to the optimization of construction and operation. The transformation of existing buildings thus opens up a wide range of opportunities for sustainable use and efficient conservation of resources (Aigwi et al., 2023).

2.1.2 Drivers for Circular Economy in the construction industry

The adoption of the circular economy in the construction industry is driven by various political, economic and technological initiatives aimed at promoting sustainable construction practices and maximizing resource efficiency (Aigwi et al., 2023; Gebetsroither et al., 2024; Munaro & Tavares, 2023). These drivers are supported by international agreements, regional strategies and financial incentives that motivate companies to accelerate the transition from linear to circular economic models (Gebetsroither et al., 2024). This subchapter presents the main drivers for the circular economy in the construction industry, including the EU Taxonomy, circularity indicators and other drivers & benefits collected from the literature.

Political Drivers

There are a number of politically and economically driven initiatives and projects that aim to promote sustainability and circularity in the construction industry (Eisele et al., 2020). Gebetsroither et al. (2024) mention how these movements are often driven by international agreements and regional strategies that set concrete measures and frameworks to support sustainable and circular construction. Political measures such as international climate agreements oblige countries to reduce their CO_2 emissions and implement more environmentally friendly practices. Economic incentives and regulations motivate companies to use sustainable technologies and materials that reduce waste and minimize resource consumption. These initiatives promote the transition from a linear to a circular economic model in the construction industry by supporting the recycling and reuse of building materials, promoting the use of renewable energy and developing innovative construction practices (Charef et al., 2021). Through a combination of political guidelines and economic incentives, the construction industry is increasingly being encouraged to work in a more sustainable and circular way (Gebetsroither et al., 2024).

Institutional Drivers

A key driver for the circular economy in the construction industry is the EU taxonomy. Since the Paris Agreement in 2015, countries and companies are increasingly facing the challenge of implementing circular practices (Eisele et al., 2020). The European Union has recognized this need and launched the “Action Plan: Financing Sustainable Growth” to redirect capital flows towards sustainable investments and thus promote a low-emission, resource-efficient economic system (Directorate-General for Financial Stability, Financial Services and Capital Markets Union, 2020). A core element of this action plan is the EU taxonomy, which provides a classification system for assessing the sustainability of economic activities, including the construction industry. It defines six key environmental targets that construction projects must meet to be considered sustainable. These objectives include mitigating the effects of climate change and adapting to them, using water and marine resources sustainably and protecting them, implementing a circular economy, preventing and controlling pollution, and conserving and restoring ecosystems and biodiversity. The taxonomy creates clear, transparent rules that help companies to assess their activities for sustainability while benefiting from financial incentives. This drives the construction industry to increasingly integrate circular principles, as companies can access sustainable financing and tax benefits (Eisele et al., 2020; Gebetsroither et al., 2024).

Technical Drivers

Circularity Indicators (CIs) are another important tool for promoting the circular economy in the construction industry (Benachio et al., 2020). These indicators measure the degree of circularity of a construction project by evaluating factors such as the use of primary raw materials, the recycling rate and the lifespan of the materials used. A common tool used in the construction industry is material passports, which provide detailed information about the materials used in a building and their recyclability. These passports help to make the environmental impact of a building transparent and enable an efficient assessment of circularity (Cottafava & Ritzen, 2021). Innovative platforms such as Madaster facilitate the collection and analysis of material data by enabling decision-makers to catalogue a building's material inventory and assess recycling potential. These tools are instrumental in operationalizing the circular economy in the construction industry by providing concrete data that can be integrated into the planning and construction process (Hebel & Heisel, 2022). Munaro and Tavares (2023) complement this perspective with further specific drivers for the circular economy in construction. Technological drivers emphasize the development of guidelines and tools to implement circular economy in

construction as well as integrated information systems to improve material certification and resource use.

Economic Drivers

Economic drivers play a crucial role in promoting the adoption of circular economy principles in the construction industry. These drivers include the reduction of material resource consumption, which not only conserves valuable resources but also lowers costs associated with procurement and waste disposal (Aigwi et al., 2023). Additionally, extending the useful life of buildings and increasing their usability enhances their economic value, while the creation of affordable housing addresses pressing societal needs. Incentives for circular business models, such as establishing physical and online marketplaces for material circularity, further encourage the reuse and recycling of products. Assurance schemes for recycled materials and leveraging the financial benefits of the data and sharing economy also promote sustainable practices. Exploring the costs and scalability of low-waste building techniques offers further potential for economic viability, making circular strategies an attractive alternative to traditional linear practices (Munaro & Tavares, 2023).

Social, Cultural & Historic Drivers

Additionally, social, cultural and historic drivers also play an important role in promoting the circular economy (Aigwi et al., 2023; Munaro et al., 2020). Aigwi et al. (2023) emphasize the social, cultural and environmental benefits. Social benefits include promoting urban regeneration, improving quality of life and strengthening social cohesion. Cultural and historical drivers include the preservation of cultural values and historic buildings, while environmental drivers include the reduction of waste, lower energy consumption and the reduction of greenhouse gas emissions.

A full list of drivers identified by the authors mentioned can be found in Appendix I. These drivers illustrate how different factors interact to drive the circular economy in construction and enable more circular construction projects.

2.1.3 Barriers for Circular Economy in the construction industry

The implementation of circular building transformations faces numerous challenges that can hinder its successful completion (Eisele et al., 2020). Although the importance of the circular economy in the construction sector and the associated benefits are increasingly recognized, these projects often face significant obstacles in practice (Charef et al., 2021). Based on the work of Charef et al. (2021), Aigwi et al. (2023), Eisele et al. (2020) and Munaro and Tavares (2023), the barriers can be divided into the following categories.

Technical barriers

Technical challenges are often linked to the complexity of implementing circular strategies in the built environment. The existing building structures can be intricate and not easily adaptable for circular methods, making it challenging to integrate circular principles into traditional construction processes (Aigwi et al., 2023). This complexity is compounded by a lack of standardized methods for dismantling, reusing, and repurposing building materials, which hampers scalability across projects. Furthermore, the technical tools needed to facilitate circular construction, such as advanced material tracking and design-for-disassembly technologies, are still in development and not widely available. Separating materials in a way that preserves their quality and allows for reuse is particularly challenging, as traditional construction practices do not prioritize this aspect (Munaro & Tavares, 2023).

Economic Barriers

Economic factors play a significant role in discouraging the adoption of circular practices. The high initial costs associated with circular construction, such as those for specialized materials and processes, can deter developers who are concerned about the financial feasibility of projects (Charef et al., 2021). In addition, the difficulty of obtaining financial incentives or subsidies and their insufficient amounts for circular projects makes these endeavors less attractive compared to conventional, linear construction methods. Uncertainty about the profitability of circular projects adds to the hesitation, especially when the market for recycled materials remains underdeveloped, limiting potential cost savings. The relative affordability of traditional construction methods further perpetuates reliance on linear practices, as circular methods are often perceived as more costly with unclear returns (Munaro & Tavares, 2023).

Regulatory Barriers

Regulatory frameworks can be inflexible, complicating the implementation of circular practices. Strict building codes often prioritize safety and stability requirements that may conflict with circular strategies, particularly when reusing materials with uncertain quality standards (Aigwi et al., 2023). The lack of regulatory flexibility and support for circular innovation creates additional bureaucratic hurdles. Complicated approval processes and slow adaptation of building codes to include circular practices add another layer of difficulty, delaying project timelines and deterring developers from pursuing circular approaches (Eisele et al., 2020; Munaro & Tavares, 2023)

Social Barriers

Social acceptance and awareness are crucial for the successful adoption of circular economy principles in construction. However, there is often a lack of awareness and understanding of circular practices among industry professionals and the general public. This gap in awareness results in limited demand for circular construction and, at times, resistance to change within the industry. Many stakeholders, including developers, contractors, and clients, remain accustomed to traditional methods and may view circular practices as unnecessary or overly complicated. This resistance can be rooted in a lack of familiarity with the long-term benefits and a tendency to prioritize immediate costs over future gains (Charef et al., 2021; Munaro & Tavares, 2023).

Environmental Barriers

Environmental challenges arise from difficulties in managing the environmental risks associated with material reuse, such as contamination, hazardous substances, and emissions (Charef et al., 2021). Circular construction practices rely on a robust infrastructure to support recycling, reprocessing, and safe material handling, which is often lacking. The inadequate availability of recycling facilities, as well as the absence of circular supply chains for reused materials, limits the extent to which circular practices can be effectively implemented. Additionally, ensuring that materials meet environmental standards and do not pose health risks when reused requires further innovation and infrastructure investment (Munaro & Tavares, 2023).

Management Barriers

Effective project management and collaboration are essential to successful circular construction. However, the lack of collaboration frameworks and limited knowledge of circular practices among stakeholders presents a significant barrier (Aigwi et al., 2023). Circular construction projects require coordination across multiple actors, including architects, engineers, contractors, and suppliers, yet the absence of clear governance structures often leads to miscommunication and inconsistent implementation of circular practices. Inadequate planning processes, coupled with the lack of strategic oversight, make it challenging to integrate circular economic principles at every stage of the project lifecycle. To effectively manage circular

projects, it is necessary to build knowledge-sharing networks and establish governance frameworks that prioritize circular objectives (Munaro & Tavares, 2023).

A full list of the barriers identified by the authors mentioned can be found in Appendix II. These barriers highlight the complex factors that need to be addressed to drive the circular economy in the construction industry.

2.1.4 Circular building transformation

While the circular economy fundamentally aims to conserve resources, reduce waste and minimize the ecological footprint, the transformation of existing buildings plays a key role in the construction industry (Hamida et al., 2023). Instead of demolishing buildings and building new ones, existing structures are adapted to new usage requirements and reused, which brings both ecological and economic benefits (Aigwi et al., 2023). The transformation of existing buildings is based on various terms and concepts. The following overview presents approaches to defining circular building transformation:

- **Adaptive Reuse:** According to Aigwi et al. (2023), adaptive reuse aims to preserve the cultural and social identity of existing, underutilized buildings. In doing so, it contributes to circular development by reducing energy consumption, material use and pollution in the construction industry. Adaptive reuse is thus seen as a central component of a circular transformation of existing buildings, as it minimizes the use of new resources while reusing existing structures.
- **Revitalization:** Eisele et al. (2020) use the term 'revitalization' to describe different types of interventions in the building structure, ranging from minor additions such as balconies to large-scale extensions or additions. This definition focuses on the structural remodeling of a building to adapt it to new usage requirements. They also emphasize the circularity of such measures, particularly in an urban context, where adding stories to existing buildings helps to reduce land consumption.
- **Transformation:** Waldburg et al. (2022) define the transformation of existing buildings as a comprehensive functional and structural remodeling that makes it possible to open up a property for new types of use. They emphasize that transformations often lead to an expansion of the range of uses, which strengthens resilience to market fluctuations. These transformations are seen as an alternative to demolition and new construction, resulting in both economic and environmental benefits.

Several common characteristics can be derived from the above descriptions by Aigwi et al. (2023), Eisele et al. (2020), Munaro and Tavares (2023) and Waldburg et al. (2022) that are relevant to circular building transformation, using them the following definition can therefore be derived for this work:

Circular Building Transformation is the process of comprehensive structural and functional remodeling of existing buildings, considering the principles of the circular economy, extending their operational life, conserve materials and reduce environmental impact. The adaptability of the building is promoted to meet future utilization requirements, and the social and cultural values of the buildings are preserved.

The transformation of existing buildings is a complex process that can be characterized by three key dimensions, shown in Figure 10: constructional transformation, environment & location and stakeholder management. Each of these dimensions plays a central role in the success of a building transformation and significantly influences how the building meets the requirements of the circular economy (Waldburg et al., 2022).

Figure 10: The three-dimensional transformation process
Source: (Waldburg et al., 2022, p. 10, author's translation)

Every transformation of an existing building requires structural adaptations. These result from the need to adapt the building to new uses, as the original use often no longer offers any economic prospects (Eisele et al., 2020). The constructional transformation makes it possible to use the potential of the existing structure and at the same time meet the requirements of the new use without the need for a completely new building. These adaptations make a decisive contribution to saving resources and minimizing the ecological footprint (Waldburg et al., 2022).

Transformation projects are closely linked to the urban environment and the location of the building (Haynes & Nunnington, 2010). Historic buildings often have a close connection to their surroundings, which presents both opportunities and challenges (Dişli & Ankaralıgil, 2023). In the best case, the location offers new potential after the transformation, which has a positive effect on the project. A frequent example of this is the architectural character of the urban environment, which can be used as “historical-emotional” branding during the transformation. The urban environment and the cultural ties of the building can play a central role in the decision to transform, as they both increase the value of the project and promote circularity (Waldburg et al., 2022).

Another decisive factor for the success of transformation projects is stakeholder management. The early involvement of relevant interest groups, such as authorities, residents, investors and future users, is essential to create broad acceptance of the project (Williams & Dair, 2007). A comprehensive communication strategy ensures that potential conflicts are addressed at an early stage and that the interests of the various stakeholders can be considered. The transformation process often proves to be a politically and socially accepted alternative to demolition and new construction. Particularly in urban areas, transformation can contribute to the revitalization of the surrounding area and thus generate both economic and social benefits (Waldburg et al., 2022).

These three dimensions make it clear that structural adaptation, integration into the urban environment and early stakeholder management are key success factors for the transformation of existing buildings. Additionally, several determinants and prerequisites are important for the practical application for circular building transformations, which can be found in Table 1.

Table 1: Determinants and Prerequisites for Circular Building Transformations

Category	Determinant/ Prerequisite	Explanation/Example	Source
Constructional Transformation	Configuration flexibility	The ability of a building's layout to adapt to new uses without significant structural changes.	(Hamida et al., 2023)
	Product dismantlability	Ease with which building components can be disassembled and reused in new projects.	
	Design regularity	Consistent design elements that facilitate easier reuse and maintenance of materials.	
	Functional convertibility	Ability to repurpose spaces for different functions, such as converting offices to apartments.	
	Building maintainability	Designs that ensure long-term maintenance with minimal resource use.	
	Resource recovery	Systems to recover and reuse materials from demolition or renovation.	
	Volume scalability	Flexibility to expand or reduce building space according to future needs.	
	Asset refit-ability	Capability of existing assets to be retrofitted for modern standards or circular goals.	
Environment & Location	Sector & organization cultures	Influence of industry norms and organizational practices on project outcomes.	(Kooter et al., 2021)
	Knowledge flows	Sharing technical and managerial knowledge among stakeholders.	
	Power and tensions	Balancing diverse stakeholder interests to prevent conflicts.	
	Transparency and trust	Clear communication and accountability to build trust among project participants.	
Stakeholder Management	Top-Down support	Commitment from leadership to prioritize circular practices.	

	Partnership based on equality	Collaborative relationships where all partners have equal say and shared goals.	
	Shared circular goals	Unified objectives among stakeholders to achieve circularity.	
	Involvement of motivated people	Engagement of individuals passionate about circular practices.	
	Flexibility	Willingness to adapt to new information, challenges, or technologies during project execution.	
	Reciprocal relationships	Mutual exchange of resources, information, and benefits among stakeholders.	
	Project team identity	Cohesive teams with shared vision and commitment to project success.	
	Struggle for new roles	Adapting to new roles required by circular practices, such as material managers or sustainability leads.	
	Pioneering leadership	Leaders driving innovation and commitment to circular transformations.	
	Continuity in staffing	Ensuring consistent team members throughout the project for smooth execution.	

The determinants and prerequisites for circular building transformations provide a clear link to the feasibility of implementing the theoretical principles of the circular economy. Hamida et al. (2023) and Kooter et al. (2021) provide valuable insights into the concrete requirements that need to be considered when applying circular economy principles in construction projects. They help to translate the theoretical principles into practical measures by systematically breaking down the factors that influence the success of circular projects.

2.2 Project Selection

This chapter aims to address the current process of project selection in the construction sector. It starts by introducing font-end management in chapter 2.2.1. Following this, the project selection process is explained in chapter 2.2.2.

2.2.1 Front-End Management

Front-end management is the crucial starting point in the project development process, as this is where the foundations for the subsequent success of a project are laid. In this early phase, where ideas are formulated, feasibility is examined and project strategies are defined, the foundation is laid for the direction and structure of the project. Careful planning in front-end management leads to a higher probability of success and can have a positive influence on the entire course of the project (Rokio et al., 2024). A study by the World Bank in 1996, which examined the success of 1,125 projects, showed that projects with strong front-end management had an 80 % success rate, compared to only 35 % for projects with inadequate front-end management. These results illustrate that thorough planning at this stage can significantly stabilize projects and improve the chances of realization (Olsson & Samset, 2006). Figure 11 illustrates the potential to influence costs in the early project phases, though this potential decreases rapidly as planning progresses. Targeted front-end management can optimize not only the initial construction costs, but also the costs incurred in the subsequent utilization- and end-of-life-phase of a building. Decisions in this phase have a direct impact on factors such as energy efficiency, maintenance costs and disposal. Forward-looking planning and the targeted selection of sustainable technologies and materials can have a positive impact on the entire life cycle of a project and enable long-term cost savings (Friedrichsen, 2024).

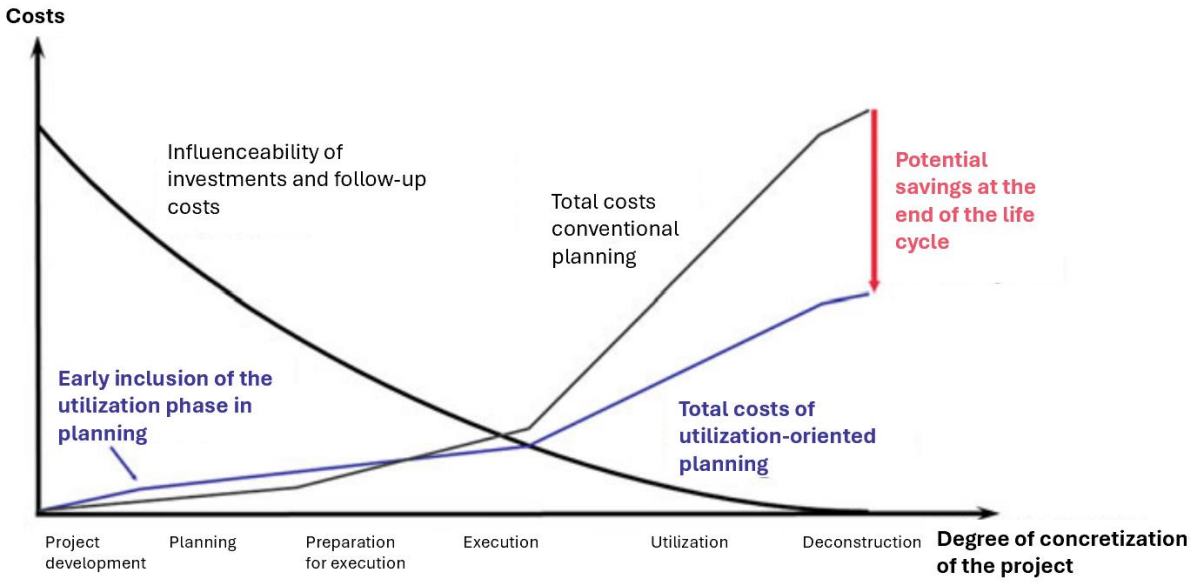

Figure 11: Influenceability of costs during a project
Source: (Friedrichsen, 2024, p. 8, author's translation)

Front-end management also entails the evaluation of the basic project idea (Olsson & Samset, 2006). It is necessary at this stage to question the project and possibly abandon it if the idea proves unsustainable. This is crucial, as projects should not be driven forward uncritically; instead, the focus must be on long-term value creation (Edkins et al., 2013). This is where decisions come into play that define the project's potential to generate value and the criteria by which value is to be measured. Especially when planning transformation projects of existing buildings, as is the case with circular building transformations, the complexity increases as the

existing structures often pose significant technical challenges and introduce the need for innovative ways of working. Front-end management offers a valuable possibility to integrate circularity into construction projects, by integrating circular principles at an early stage and establishing circularity as a fundamental value of project. This way, the challenges of the circular economy and the adaptation requirements of existing buildings can be tackled in a more targeted and sustainable manner (Rokio et al., 2024).

2.2.2 Project selection process

A central concern in the selection of projects is the creation of added value for all stakeholders involved. A basic prerequisite for stakeholder participation in projects is the expectation that the resulting benefits outweigh the necessary sacrifices (Rokio et al., 2024). This value creation is still predominantly defined by the success measurements of time, cost and quality/scope, also known as the iron triangle. Which means that most analysis methods will test whether a project would be manageable on time, within budget, and to a defined quality (Pollack et al., 2018). Since the 1970s, when project management was first being studied, the Iron Triangle - also known as the Triple Constraint (budget, scope, schedule) - has been a key component of the discipline. Even though a substantial amount of research claims that the Iron Triangle does not fully capture the story of project success measurement, does its criteria hold a dominant position in our comprehension of whether a project has been delivered as planned (Pollack et al., 2018).

The selection of suitable projects for real estate development is a complex and strategic process based on a variety and multiply stages of evaluation and analysis methods (Pekuri et al., 2015). This process is critical to long-term profitability and the achievement of organizational goals, as it helps to allocate resources efficiently and create value (Musarat et al., 2024). The criteria for project selection vary depending on the type of organization and the business environment. These criteria include:

- Environmental criteria
- Financial criteria
- Institutional criteria
- Management support criteria
- Risk criteria
- Technical criteria.

Here the environmental criteria refer primarily to the working environment of the project team and conflict management, rather than environmental factors such as sustainability or the circular economy. A selection process that is tailored to the specific needs of an organization minimizes coordination and management difficulties and thus contributes to project success (Musarat et al., 2024). The selection criteria should not only focus on the immediate project outcomes, but also on the long-term management capabilities of an organization, particularly in terms of resource and value management (Pekuri et al., 2015). Figure 12 illustrates Pekuri et al. (2015) two-stage approach to project selection. First, projects are filtered out of the market environment to determine whether they fit the company's business model - filter one. This step also determines whether a company is interested in working on circular building transformations in general. Projects that meet company-specific criteria then go through a second filter that assesses the ratio of risk to potential profit. Only projects that successfully pass both filters are transferred to project realization. The remaining projects that do not meet the company’s business models are generally only implemented on an ad hoc basis and are not subject to standardized project management. This model illustrates how systematic filtering methods facilitate the decision-

making process and focus the selection on projects that are both economically viable and strategically sensible.

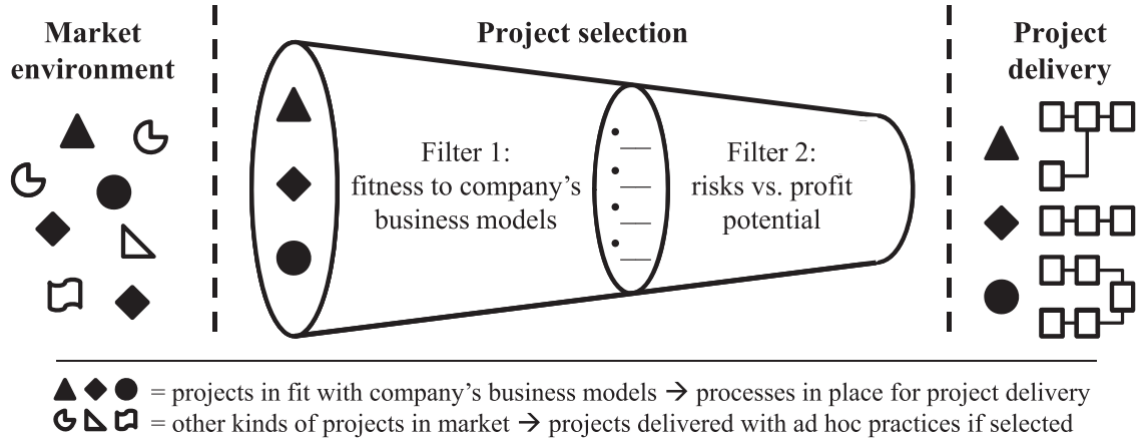

Figure 12: Two-stage approach to project selection
Source: (Pekuri et al., 2015, p. 186)

Filter two can be explained in detail by using Figure 13, which shows the selection process according to Friedrichsen (2024). It includes the steps status analysis, project idea / conception and profitability analysis. Each of these steps comprises specific fields of analysis that contribute to the decision-making process.

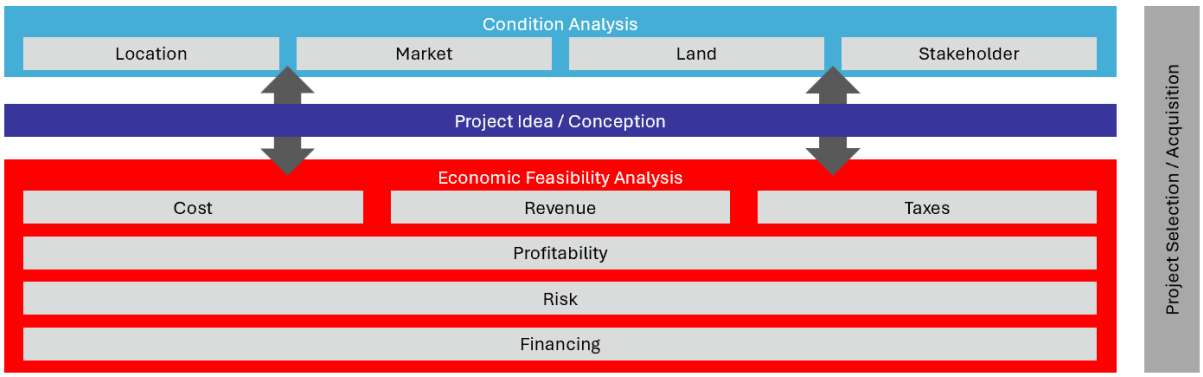

Figure 13: Sub-tasks of the project development
Source: (Friedrichsen, 2024, p. 7, author's translation)

In the following part of the chapter, the individual analysis steps are discussed to explain the evaluation process and the underlying criteria in project selection in more detail.

Condition Analysis

The condition analysis includes a comprehensive review of the location, market, land and stakeholders. This enables an in-depth understanding of the initial situation and forms the basis for a well-founded project evaluation (Friedrichsen, 2024). This step is particularly important for existing buildings, as existing structures and their conditions have a significant influence on the potential for conversion and transformation (Friedrichsen, 2024; Rymarzak & Siemińska, 2012).

The **location analysis** is an essential part of project development and is used to determine the suitability of an existing site for different types of use. If a proposed site already exists, the focus is on evaluating the existing conditions to determine the most suitable use. If a specific project idea or utilization concept already exists, the location analysis helps to assess whether the location meets the requirements of the users and is therefore suitable for the planned project

(Friedrichsen, 2024). The analysis is carried out at both macro and micro level (Rymarzak & Siemińska, 2012): the macro location analysis looks at the city or municipality and often assesses the attractiveness of the location using city categories according to their national or international importance (bulwiengesa, 2024). The micro-location analysis, on the other hand, focuses on the specific district in which the project is located and takes into account specific location factors that are required for the respective use (Rymarzak & Siemińska, 2012). The analysis usually includes the aspects shown in Table 2.

Table 2: Aspects for location analysis

Aspect	**Explanation**	**Source**
Geographical Location	Evaluates the physical location of the site, including proximity to key infrastructure and natural features.	(Friedrichsen, 2024)
Traffic Structure	Assesses accessibility via roads, public transport, and connectivity to major hubs.	
Economic Structure or Neighboring Uses	Examines surrounding economic activity and the compatibility of neighboring uses with the proposed project.	
Image	Considers the reputation and public perception of the location or neighborhood.	
Environment	Analyzes environmental factors, such as pollution levels, green spaces, or susceptibility to natural hazards.	
Technological Progress	Looks at the level of technology adoption and availability in the region, such as internet connectivity or smart city initiatives.	(Rymarzak & Siemińska, 2012)
Cultural Changes	Reviews shifts in cultural trends that could impact the use or perception of the site.	
Taxation System	Evaluates the tax policies and incentives that may affect the financial feasibility of the project.	
Sociodemographic Changes	Studies population trends, such as age distribution, income levels, and diversity, to determine potential user needs.	(Friedrichsen, 2024)
Financial System	Examines the availability of financing options, interest rates, and local investment climate.	
Government Policies	Analyzes regulations, zoning laws, and government initiatives that could influence project feasibility.	
Globalization	Looks at how global trends and international dynamics impact the attractiveness of the site.	
Demand Factors	Assesses the market demand for the proposed use of the site, including user preferences and market trends.	(Rymarzak & Siemińska, 2012)
Supply Factors	Examines the availability of similar developments in the area and potential competition.	

In Circular Building Transformation, the location not only influences the potential use of a building, but also key factors such as the availability and accessibility of materials, labor and infrastructure for the implementation of the transformation (Rokio et al., 2024). The choice of location therefore has a direct impact on supply chains and logistics, which are crucial for a successful and resource-efficient transformation.

The aim of the **market analysis** is to assess the current and future market situation to develop a project for which there is demand at the planned location. A well-founded market analysis makes it possible to examine and compare the supply and demand side for various potential uses. This ensures that the project meets the requirements and expectations of the market, increasing the likelihood of successful implementation and long-term use (Friedrichsen, 2024; Rymarzak & Siemińska, 2012). When analyzing the market, the demand and supply factors for different property types such as industrial space, residential space, retail space and office space are particularly relevant, as a transformation often aims to combine several types of use in a new, versatile concept (Eisele et al., 2020). The table listing the specific supply and demand factors for each real estate category can be found in Appendix III. The market analysis also includes a potential analysis and a price analysis. The potential analysis evaluates the development potential of the property, considering long-term demand and market trends. The price analysis examines the current rental and purchase prices as well as price development trends in the region. This enables an assessment of whether the location is competitive compared to similar locations. The price analysis supports the viability assessment and helps to develop an appropriate price structure for the project (Friedrichsen, 2024).

The **land assessment** serves to check whether the selected plot of land and the existing building structures and components meet the requirements for the planned project. This step ensures that the legal, ecological, infrastructural and structural requirements are met in order to enable legally permissible, economically viable and sustainable use (Friedrichsen, 2024). First, the building use must be clarified, including the type and extent of the building use, the possible construction method and the distances to be maintained. These specifications ensure that the planned project complies with local building regulations and development plans. In the case of existing buildings in particular, building law restrictions that could result from the original use and may require structural adjustments must be taken into account (Eisele et al., 2020). A detailed property and building fabric analysis is required in order to understand the scope of the necessary adaptations and potential environmental impacts (Eisele et al., 2020; Friedrichsen, 2024; Rokio et al., 2024). This helps the decision whether refurbishment or conversion is possible and economically viable (Eisele et al., 2020). The assessment should include:

- **Load-bearing capacity and stability**: the building must be structurally capable of bearing future utilization loads. A detailed review of the structural requirements is necessary to determine whether the building can withstand the necessary adaptations or extensions (Glückert, 2023).
- **Building materials:** Analyzing the materials used in the existing structure is important to assess their longevity, energy efficiency and suitability for sustainable use (Glückert, 2023). In older buildings, materials may have been used that are now considered harmful to the environment or involve additional refurbishment requirements (Friedrichsen, 2024).
- **Energy efficiency:** An important point is the energy assessment of the building envelope and the technical building installations. Existing buildings often need to be adapted in terms of insulation, heating and cooling systems and thermal insulation in order to fulfil modern energy-saving standards (European Parliament, 2024).

- **Adaptability:** A key issue for existing buildings is their adaptability to new uses. Figure 14 gives an overview of relevant building and planning parameters that need to be taken into account (Eisele et al., 2020).

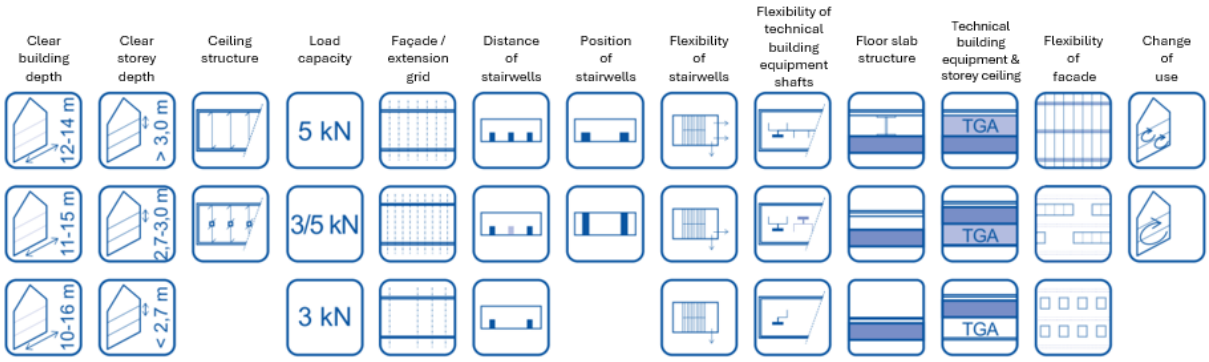

Figure 14: Overview of building & planning parameters for the adaptability of buildings
Source: (Eisele et al., 2020, p. 87, author's translation)

Additionally Friedrichsen (2024) mentions that in case of circular building transformation analysis about the monumental & environmental protection requirements, surface sealing and utilization of existing infrastructure needs to done.

The **stakeholder analysis** helps to systematically identify and assess the various actors that have an influence on the project or are influenced by the project. Stakeholders include a variety of groups, including shareholders, employees, future tenants, suppliers, lenders, authorities, the public and nature. These groups have different expectations, demands and influences that need to be integrated into the planning and realization process (Rokio et al., 2024; Senaratne et al., 2023). An in-depth understanding of stakeholder needs and expectations supports the development of targeted communication strategies to inform and involve those involved appropriately. This strategic involvement of stakeholders enables resources to be utilized more effectively and potential conflicts to be addressed proactively (Friedrichsen, 2024). The stakeholder analysis process comprises the following steps:

- **Identification**: Firstly, all potential stakeholders who are affected by or have an influence on the project are identified.
- **Assessment**: In the next step, the stakeholders' attitude towards the project, their expectations, possible conflicts and their influence on the success of the project are assessed.
- **Prioritization and management:** Based on these assessments, the stakeholders are assigned to different categories and managed using suitable strategies (Friedrichsen, 2024).

Especially for circular building transformations, effective collaboration among key stakeholders is crucial to achieving circularity and reducing negative sustainability impacts across the entire lifecycle of the project (Senaratne et al., 2023).

Project Idea & Conception

In this step, the possible types of use for the property or plot of land are defined. This phase is particularly essential for transformation projects in which existing buildings are to be put to a new use. It must be ensured that the planned use meets both the market requirements and the company's strategic objectives. The development of a viable project idea requires a comprehensive information base. A variety of sources should be consulted about this, such as

contacts with users and key people from business, politics and culture, as well as market research data and assessments from authorities and brokers. In addition, market observations in specialist media, at trade fairs or in the literature support the idea generation process and provide valuable insights (Friedrichsen, 2024). The intuitive development of ideas also plays a role here, as it often provides the initial inspiration for innovative usage concepts (Sah et al., 2010). This phase focuses on the requirements of future users. The following documents are created for this purpose:

- **Utilization concept:** Includes all essential project ideas and basic information as well as the user specifications.
- **User requirements program:** Serves as a guideline for the project objectives and defines the specific requirements of the users in terms of space, functionality, design, budget and time frame.
- **Requirements planning:** Contains a functional, room and equipment program and defines the requirements for the necessary equipment of the rooms with operating and building technology, including equipment and furnishings (Friedrichsen, 2024).

An increasingly important aspect in the design phase is the integration of mixed use - such as living, working, retail and leisure - in projects. In urban and district planning, mixed use is increasingly being used as a means of revitalizing monofunctional districts from the 1960s and 1970s with increased diversity. These approaches, which were previously based on the separation of functions, often led to neighborhoods becoming deserted at certain times of the day and losing their attractiveness. By integrating different uses projects can not only be made more economically attractive, but also more socially and ecologically sustainable (Eisele et al., 2020). According to a study of 129 German transformation projects, the original building types are often office or industrial buildings that have been converted into mixed use buildings, see Figure 15 (Waldburg et al., 2022).

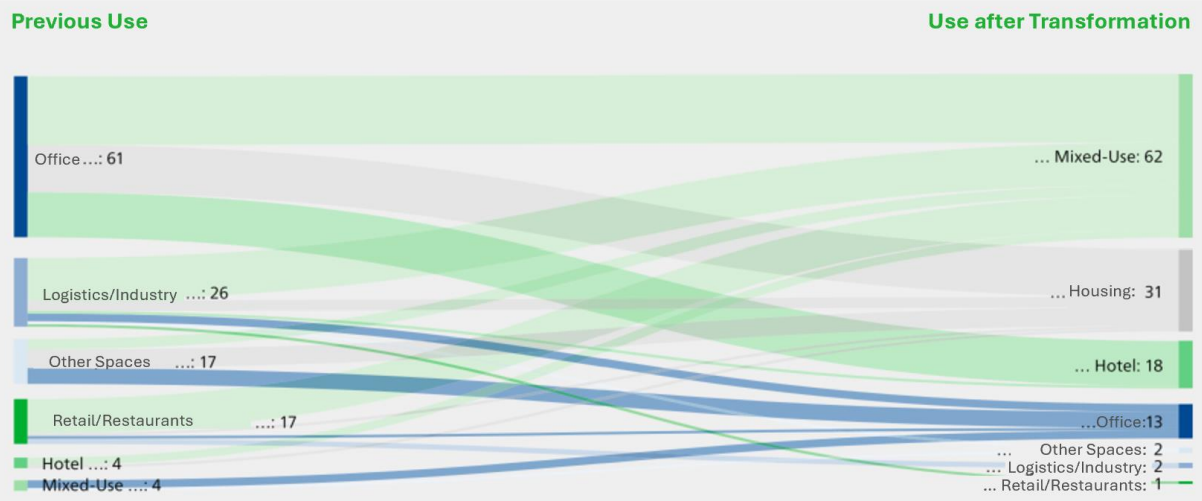

Figure 15: Previous use and use after transformation of German transformation projects
Source: (Waldburg et al., 2022, p. 25, author's translation)

In transformation projects, especially when existing buildings are to be converted to a new use, the analysis of the existing building structure plays a decisive role. It must be investigated which uses can be implemented in the existing structure, which parts of the building can be retained, and which must be demolished. It is important to check whether the removed components can be reused. Ideally, materials and components can be reused within the same project or in other projects in order to conserve resources and support the material cycle (Eisele et al., 2020).

Economic Feasibility Analysis

The economic feasibility analysis is a crucial step in project development and is used to assess the economic potential and profitability of a real estate project. It aims to determine the value of a property at a specific point in time for a specific purpose, considering both the characteristics of the property and the underlying economic factors of the market. This analysis is particularly important to ensure the long-term profitability of a project and to make informed investment decisions (Eisele et al., 2020; Friedrichsen, 2024; Mooya, 2016). The main influencing factors for assessing the profitability of a project include

- **Costs:** Total cost of building, maintaining and operating the property.
- **Income:** Expected income generated by the project, for example through rental income or sales proceeds.
- **Taxes:** Tax impact on the project, affecting both short-term and long-term profitability.
- **Profitability:** The potential of the project to generate long-term profits.
- **Risk:** The uncertainties associated with the project, such as market changes, economic developments and legal changes.
- **Financing:** The structure and terms of the financing chosen for the project, including interest rates and maturities (Mooya, 2016).

An important aspect of the economy feasibility analysis is the risk analysis, especially in the case of circular building transformations, as additional uncertainties must be considered here. A particular risk when renovating or converting existing buildings is that the building fabric can often not be adequately assessed from the outside. Damage or defects in the load-bearing structure, insulation or material condition can often only be detected through complex and expensive tests, such as drill core examinations, material analyses or non-destructive testing methods. This type of testing not only requires specialized experts but also incurs high costs. Due to these financial burdens, such tests are often not carried out as part of the project acquisition process. Instead, reliance is usually placed on the external assessment of the building and existing building plans, which can lead to unforeseen problems as the project progresses. Undetected structural weaknesses or material damage can significantly increase refurbishment costs and lead to delays in the project schedule, which significantly increases the financial risk for investors and developers (Glückert, 2023). Another particularly important aspect of risk analysis in the refurbishment of existing buildings is the potential health risks posed by pollutants. In the case of structural measures, potentially harmful substances must be expected in the existing building fabric. Frequently encountered pollutants include asbestos, polychlorinated biphenyls (PCBs), heavy metals and mold. Such substances pose a risk to the health of workers and residents and must be identified and assessed before construction work begins (Friedrichsen, 2024).

A major criticism of traditional economic feasibility analyses is that they often only take planning and construction costs into account, even though buildings often have a useful life of 50 to 80 years. Maintenance costs and circularity aspects are usually only insufficiently considered in these analyses. The ecological footprint, the long-term effects on the climate and resource efficiency hardly play a role (Mooya, 2016). The only quantified topics associated with sustainability usually relate to government grants or subsidies that offer additional financial incentives. Advanced approaches such as benchmarking and life cycle costing could complement these analyses, as they consider not only the costs during the construction phase, but also the environmental and economic impact over the entire life cycle of the building. Such methods provide a more realistic assessment of long-term viability and sustainability and could form the basis for further consideration and discussion in interviews to deepen the analysis of viability criteria in real estate development (Friedrichsen, 2024).

These various analyses are closely interlinked and are considered during project development to create a strategically sound basis for decision-making. For example, findings from the location and market analysis can influence the economic evaluation by showing how the location could affect potential earnings and risks. Similarly, the stakeholder analysis can provide important information for the risk analysis, as certain interest groups may pose specific risks to the project. In summary, it is the interplay of these analysis methods that provides project developers with a holistic view of the planned project. By integrating and weighing up all factors, project decisions can be made that optimally consider the economic, legal and social requirements as well as the strategic and long-term goals of the organization. This creates a decision-making process that is not only geared towards short-term profits, but also towards sustainable and future-oriented project success.

2.3 Connecting Circularity Principles with project selection methods

The integration of circular economy principles into project selection processes represents a significant opportunity for advancing sustainability in the construction and real estate sectors. However, this integration is complex and requires careful consideration of both the theoretical underpinnings and practical constraints. A detailed analysis of the literature highlights synergies between circular economy principles and project selection methods but also uncovers critical challenges, particularly in terms of economic feasibility, implementation barriers, and the need for standardized methodologies (Ellen MacArthur Foundation, 2015; Charef et al., 2021; Aigwi et al., 2023). This chapter delves into these aspects and evaluates the arguments presented in the literature.

Differences in Considered Scope

A fundamental divergence between circular economy principles and traditional project selection methods lies in their respective scopes and priorities. Circular economy principles adopt a holistic life cycle perspective, encompassing all phases of a building's existence - from design and construction to use and end-of-life (Benachio et al., 2020; Ellen MacArthur Foundation, 2015). In contrast, project selection methods often narrow their focus to the planning and construction phases, as these are seen as the most critical for determining costs, timelines, and initial feasibility (Pekuri et al., 2015). This disconnect leads to missed opportunities to integrate longer-term benefits, such as energy efficiency during the usage phase or material recovery during deconstruction. The literature suggests that bridging this gap requires embedding life cycle thinking into project selection processes. Tools such as Life Cycle Costing (LCC) and Building Information Modeling (BIM) offer practical mechanisms for assessing both financial and environmental impacts early in the decision-making process (Peiris et al., 2023). These tools not only align with circular economy principles but also provide actionable insights that can influence project selection criteria.

Economic Feasibility as a Core Challenge

Economic feasibility remains the cornerstone of project selection, governed by the "iron triangle" of cost, time, and quality/scope (Pollack et al., 2018). This framework leaves little room for measures perceived as costly, risky, or time-intensive, which is a significant challenge for the integration of circularity. Circular economy principles emphasize long-term economic benefits; however, the short-term perspective of many project developers, coupled with a lack of mature markets for recycled materials and standardized quality controls, undermines the perceived value of these measures (Charef et al., 2021; Munaro & Tavares, 2023). The literature reveals that

the economic drivers for circularity are often insufficiently quantified. While tools like Life Circle Costing (LCC) can highlight long-term savings, their adoption is hindered by a lack of familiarity and the perceived complexity of implementation (Benachio et al., 2020). Similarly, subsidies and tax incentives, while promising in theory, often fail to offset the additional costs of conducting detailed analyses or sourcing circular materials (Gebetsroither et al., 2024). Addressing these barriers requires a dual strategy: demonstrating the clear financial advantages of circularity and reducing the administrative and financial burden on developers.

Social and Knowledge Barriers

Economic challenges are compounded by social and knowledge-related barriers. The literature highlights a lack of awareness and understanding among project developers and stakeholders regarding the long-term benefits of circularity (Charef et al., 2021). Immediate cost savings are often prioritized over future gains, reflecting a broader cultural resistance to adopting innovative but untested approaches. Knowledge transfer and collaboration emerge as critical enablers for integrating circular economy principles into project selection (Munaro & Tavares, 2023). Training programs, case studies, and the dissemination of success stories can help bridge the knowledge gap. Moreover, fostering interdisciplinarity - with architects, engineers, sustainability experts, and policymakers - can create a shared vision and drive the adoption of circular practices (Peiris et al., 2023).

Regulatory and Political Drivers

Regulatory frameworks and political initiatives play a crucial role in promoting circularity. Policies such as the EU taxonomy and mandatory ESG (Environmental, Social, Governance) reporting have the potential to incentivize circular practices (Eisele et al., 2020; Gebetsroither et al., 2024). However, strict building regulations and bureaucratic approval processes often act as significant barriers. For instance, the requirement to demonstrate compliance with circularity standards can increase project timelines and costs, discouraging adoption (Charef et al., 2021). The literature underscores the importance of aligning regulatory drivers with practical implementation tools. Streamlined approval processes, standardized reporting frameworks, and accessible databases for circular materials could reduce the administrative burden and encourage wider adoption (Hamida et al., 2023). Additionally, integrating circularity into existing frameworks, such as urban planning and zoning regulations, could further embed these principles into mainstream practices.

Strategic Overlap in Location Factors

Both circular economy principles and project selection methods place significant emphasis on location factors, but their motivations differ. While project selection typically focuses on economic criteria like rental potential and infrastructure, circular economy principles consider cultural, historical, and logistical factors such as material availability and labor access (Waldburg et al., 2022). Combining these perspectives could result in more comprehensive project evaluations that balance economic and environmental objectives. For instance, prioritizing projects in areas with established recycling infrastructures or access to circular material suppliers, while expecting high rental prices, could enhance both feasibility and impact.

The analysis shows that the integration of circular economy principles into project evaluation offers both opportunities and challenges. A key point is that many of these theoretical findings have not yet been systematically integrated into standard selection processes. Due to the importance of economic feasibility parameters in project selection, it is critical to ensure that circular measures are practical and cost-effective to implement. Not all potential measures and analyses can realistically be incorporated into the project selection process. This makes it essential to prioritize and identify the most effective and impactful actions (Aigwi et al., 2023). The

next step is therefore to examine the practice by means of interviews with experts from the real estate development sector. The aim is to understand how these identified opportunities and hurdles are implemented or experienced in real-world contexts. The results of these interviews should help to develop a practical understanding of the integration of circular economy principles and derive actionable, prioritized recommendations that enable the most effective measures to be implemented, facilitating the transition to circular approaches in project evaluation.

3. Preparation and Methodology for Empirical study

This chapter outlines the preparation and methodology used for the empirical study of this research, focusing on integrating circular principles into project selection processes in the German real estate development sector. The study consists of two distinct phases: a qualitative analysis to investigate current practices, challenges, and opportunities in circular project selection, followed by a validation phase with experts to refine and substantiate the findings. This two-step approach ensures that the research outputs are both practically applicable and theoretically grounded. The general workflow can be found in Figure 16.

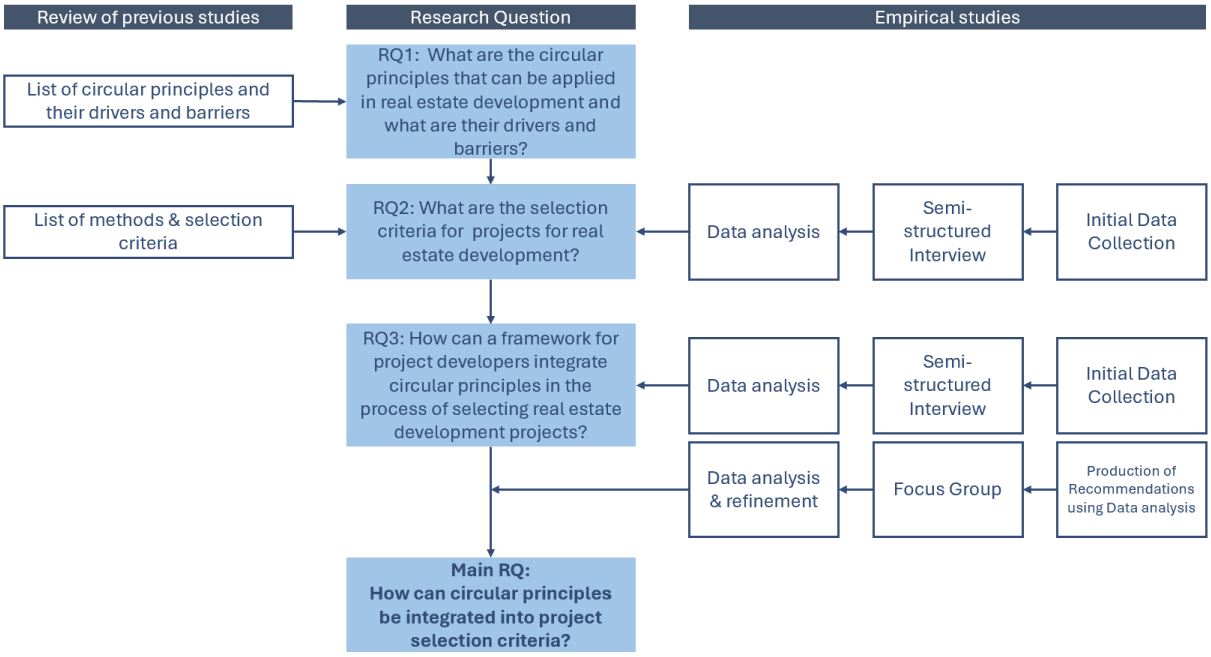

Figure 16: Empirical Study in overall Research Flow

3.1 Phase 1: Semi-structured Interviews

The first phase of the empirical study focuses on understanding how project developers in Germany currently approach project selection for building transformations. The aim is to explore the decision-making criteria, the extent of circularity in practice, and the barriers and drivers associated with adopting circular principles.

3.1.1 Initial Data Collection

The preparatory stage involved gathering secondary data to establish a robust context for the research and to identify suitable candidates for the interviews. This process ensured that interviewees were selected based on their expertise and experience with circular building transformations, aligning their knowledge with the thesis' research objectives. Key sources of secondary data included:

- Industry Reports: Provided insights into trends, market conditions, and benchmarks for circularity in real estate development, helping to identify organizations and professionals actively engaged in the field.
- Academic Literature: Offered theoretical perspectives and frameworks for circular building transformations.

- Practical Examples of Circular Projects: Focused on analyzing practical examples of circular projects executed by potential interviewees or their companies, ensuring candidates were directly involved in relevant initiatives and capable of offering informed perspectives.

This data not only laid the foundation for designing targeted interview questions but also helped ensure that discussions would be both relevant and grounded in existing knowledge. Additionally, the review process highlighted gaps in the literature and practice that the interviews aimed to address.

The following key themes emerged from the initial data collection and shaped the selection of interview candidates as well as the focus of the discussions:

- Theme 1: Circularity in Real Estate Development
- Theme 2: Project Evaluation and Selection Methods
- Theme 3: Integration of Circularity in Project Evaluation
- Theme 4: Relation between Selection Criteria and Circular Project Results

This structured approach ensured that the experts chosen for the interviews not only brought practical knowledge but also directly contributed to exploring and addressing the study's research questions.

3.1.2 Semi-Structured Interviews

Semi-structured interviews are the primary research method for this phase. They allow flexibility in exploring participants' experiences while maintaining a consistent focus on the key themes of the study. Participants were selected based on their expertise and experience with building transformations. The criteria include:

Experience with Circular Building Transformations: Interviewees should demonstrate involvement or interest in circular building transformation initiatives, whether through previous projects, current roles, or relevant publications. This includes professionals actively involved in projects that integrate circular economy principles, particularly those focusing on the reuse or adaptation of existing building structures.

Geographical Limitation and Sectoral Representation: To ensure diverse perspectives, the study targets professionals operating within Germany's real estate and construction sectors. A balanced representation from different roles and backgrounds within organizations is essential to capture varying motivations, challenges, and approaches to implementing circular principles in project selection and development.

Influence and Decision-Making Capacity: Candidates should hold positions that enable them to influence key decisions in real estate project development, such as project selection, design, procurement, or policymaking. This includes project developers, either with a technical or with a economic background or development consultants who play a critical role in shaping circular outcomes.

Willingness to Participate: Interviewees should be willing and available to share their insights and experiences. Their willingness to participate and engage in open discussions is crucial for obtaining in-depth and high-quality data that will contribute to the research objectives.

Nine experts were selected, as shown in Table 3, with almost all of them working at different companies. The only exceptions are EXP2, EXP3, and EXP7, who are from the same organization;

however, care was taken to ensure that they work at different locations within Germany and hold distinct roles to provide diverse perspectives.

Table 3: Interview Details of Experts

Actor	Role	Experience	Date of Interview
EXP1	Consultant	+ 20 years	22.11.2024
EXP2	Head of Project Development	+ 30 years	25.11.2024
EXP3	Project Manager / ESG Manager	+ 10 years	26.11.2024
EXP4	Architect	+ 20 years	29.11.2024
EXP5	Head of Project Development	+ 30 years	26.11.2024
EXP6	Technical Project Manager	+ 25 years	27.11.2024
EXP7	Technical Project Manager	+ 5 years	03.12.2024
EXP8	Architect	+ 5 years	18.12.2024
EXP9	Head of Project Development	+ 10 years	20.12.2024

Interview Process for Empirical Study

1. Initial Contact and Scheduling: All interview participants were identified and contacted through recommendations provided by a professional network. Personalized messages were sent to introduce the research topic and objectives, followed by detailed interview invitations. Each invited participant expressed their willingness to contribute and agreed to participate in the study, demonstrating a strong interest in the research topic. Interviews were scheduled based on the availability and preferences of the participants to ensure smooth coordination and active engagement.

2. Informed Consent Process: As part of the invitation, potential participants received informed consent forms, the template can be found in Appendix VIII. These forms outlined the scope of the study, the data management procedures, and the ethical considerations involved. Key aspects included obtaining permission for audio recording and transcription of the interviews. This process was essential to maintain ethical research standards, ensuring participants' privacy and the confidential handling of their information.

3. Interview Format and Setting: The interviews were conducted online, using Microsoft Teams. Each interview was planned for approximately 45 minutes, including a 10-minute buffer for introductions and closing remarks.

4. Interview Content and Structure: The interviews began with an introduction by the researcher, clearly stating the purpose of the study and the objectives of the interview. Before starting the recording, participants were reminded of the confidentiality agreements outlined in the consent forms. The interview structure was divided into several thematic sections tailored to the research objectives:

    - Understanding Current Practices: Exploring the current status and practices of circular building transformations in Germany.
    - Assessing the Role of Circular Principles: Evaluating how circularity is currently integrated into project selection criteria.
    - Barriers and Challenges: Discussing the obstacles to adopting circular principles in project selection.
    - Facilitators and Opportunities: Identifying factors that could enhance the adoption of circular principles.

- Feedback on Preliminary Recommendations: Gathering insights into initial recommendations developed from the literature and aligning them with practical experiences.
- Future Directions: Concluding with questions about potential strategies for advancing circular building transformations.

Follow-up questions were adjusted dynamically based on the interviewee's expertise and responses, ensuring the discussions remained focused and relevant. The interview questionnaire can be found in Appendix IV.

5. Anonymity and Language: All interviews were anonymized to protect participants' identities and ensure confidentiality. The interviews were conducted in English or German, depending on the interviewee's preference.

6. Transcription and Feedback: Post-interview, audio recordings were transcribed using automated tools, followed by manual edits to ensure accuracy. Interviews which have been conducted in German were translated to English. Participants were given the opportunity to review their transcriptions and provide comments or corrections, ensuring the documentation accurately captured their insights and perspectives.

3.1.3 Methodology of data analysis in phase 1

Due to the qualitative nature of this study, a thematic analysis approach was used to interpret the data, which is visualized in Figure 17.

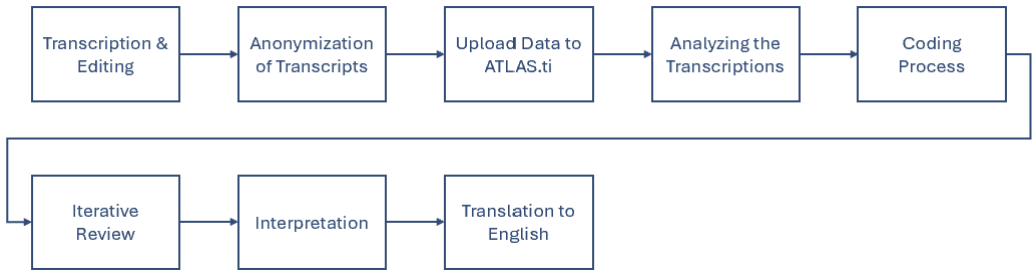

Figure 17: Workflow of Data Analysis for phase 1

1. **Transcription and Editing:** Interviews conducted with experts are automatically transcribed using Microsoft Teams. These transcriptions are carefully reviewed for accuracy and edited to ensure reliability before being used for further analysis.

2. **Anonymization of Transcripts:** To protect the privacy of participants, anonymized versions of the transcripts are created. All identifying information, such as names, company affiliations, and specific project references, is removed. These anonymized transcripts are used for all subsequent analysis.

3. **Uploading Data to ATLAS.ti:** The cleaned and edited transcriptions are uploaded into ATLAS.ti, a qualitative data analysis software. This tool facilitates the systematic organization of qualitative data, enabling efficient coding, retrieval of relevant quotes, and the exploration of correlations between codes (Hwang, 2008).

4. **Analyzing the Transcriptions:** The researcher thoroughly examines the interview transcriptions to identify key elements, such as barriers, enablers, and practical strategies for integrating circularity into the project selection process for building transformations.

5. **Coding Process:** The transcriptions are analyzed using the qualitative content analysis methodology of Mayring (2014). Initial codes and themes are guided by the conceptual framework of the study. The coding process is iterative, allowing new codes and themes to emerge as the analysis progresses. Adjustments to the coding schema are made as necessary to ensure all relevant data is captured comprehensively.

6. **Iterative Review:** The coding and themes are continuously reviewed and refined to ensure they accurately represent the interview content. This iterative review enhances the depth of understanding and ensures alignment with the research objectives of developing actionable recommendations.

7. **Interpretation:** The coded data is interpreted to extract meaningful insights, which are then used to develop tailored recommendations for integrating circularity into the project selection process of circular building transformations. The focus is on actionable and practical strategies that address both ecological and economic considerations.

8. **Translation:** Since the interviews were conducted in German, the final transcriptions and findings are translated into English after the interpretation phase. This ensures consistency and facilitates the integration of results into broader academic and professional discourse.

3.2 Phase 2: Focus Group

The second phase of the study involves validating the findings and recommendations from Phase 1 through conducting a focus group workshop. This step ensures the robustness, feasibility, and relevance of the proposed framework for circular project selection. The validation phase serves to:

- Test the practicality of the recommendations derived from phase 1.
- Gather feedback on the framework's applicability in real-world contexts.
- Identify potential improvements or gaps in the proposed approach.

Expert Selection

The focus group included experts selected to represent a variety of professional roles and insights relevant to circularity in project development. Care was taken to ensure the participants brought unique perspectives based on their expertise and responsibilities across different domains of the industry. A list of them can be found in Table 4.

Table 4: Interview Details of Experts

Actor	Role	Experience	Date of Focus Group
EXP10	Investment Manager	+ 5 years	10.01.2025
EXP11	Investment Manager	+ 5 years	
EXP12	Project Manager	+ 10 years	
EXP13	Project Manager	+ 5 years	
EXP14	Project Manager	+ 10 years	
EXP15	Project Manager	+ 10 years	
EXP16	Head of Development for Office & New Work	+ 25 years	

The decision to invite a new group of experts for the focus group workshop in phase 2 was driven by the need to diversify perspectives and deepen the analysis of the findings from phase 1. While the first phase provided rich insights through semi-structured interviews with 9 experts, these

interviews were primarily exploratory and aimed at identifying themes, challenges, and opportunities related to the integration of circular principles in project selection processes. For the focus group workshop, 7 new experts were invited to ensure the inclusion of fresh viewpoints and to avoid potential biases that could arise from revisiting the same participants. By introducing a new set of professionals with diverse expertise and backgrounds, the workshop aimed to validate the findings from phase 1, challenge initial assumptions, and generate new ideas. This approach also ensured that the focus group discussions were not constrained by the prior input of participants, allowing for an independent and critical review of the framework developed in phase 1. Furthermore, the selection of new experts was deliberate to ensure that the focus group included professionals actively involved in project development, but with diverse backgrounds and areas of expertise. Some participants, such as investment managers, brought a financial perspective, offering insights into economic feasibility and funding considerations for circular projects. Others, with technical backgrounds, contributed a deeper understanding of the practical and engineering challenges associated with implementing circular principles. Additionally, one expert in the group had extensive experience in the development of office buildings, providing a unique focus on the transformation of such spaces. This diversity ensured that the discussion addressed the full spectrum of challenges and opportunities, from financial viability to technical implementation and specific use cases like office to mixed-use transformations.

The interview process including the initial contact and scheduling for this phase were conducted in the same manner as outlined in phase 1. The focus group workshop began with an introduction to the study's purpose and the specific objectives for this validation phase. Before initiating the recording, participants were reminded of the confidentiality agreements detailed in the consent forms.

The workshop was structured into three main stages, the protocol can be found in Appendix VI. First, the researcher presented an overview of the study's progress, including the methodology, processes, and findings from the initial phase. This provided participants with the necessary context for the subsequent tasks.

In the second stage, the experts were asked to individually evaluate the developed recommendations based on two scales: **Relevance** (how important the recommendation is) and **Feasibility** (how realistic its implementation would be). This allowed for a systematic assessment of the proposed strategies.

Finally, the focus group transitioned to a collaborative discussion phase. Participants reviewed the recommendations together, providing feedback, suggesting adjustments, and proposing additional measures. This interactive dialogue was instrumental in refining the recommendations and ensuring they were both practical and aligned with industry needs.

3.2.1 Methodology of data analysis in phase 2

Due to the qualitative nature of this study, a thematic analysis approach was used to interpret the data, which is visualized in Figure 18.

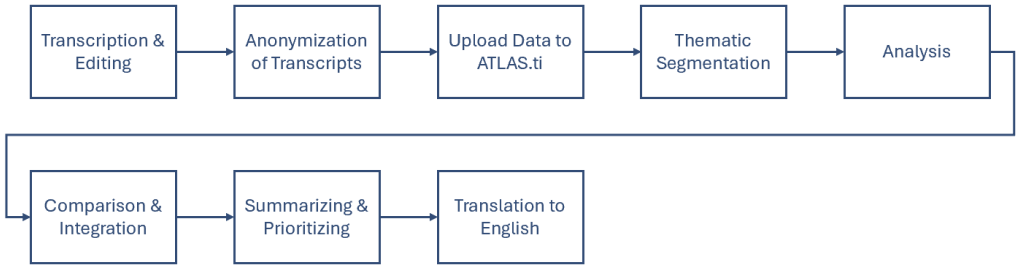

Figure 18: Workflow of Data Analysis for phase 2

1. **Transcription and Editing:** The focus group workshop conducted with experts was automatically transcribed using Microsoft Teams. This transcription is carefully reviewed for accuracy and edited to ensure reliability before being used for further analysis.
2. **Anonymization of Transcripts:** To protect the privacy of participants, an anonymized version of the transcript is created. All identifying information, such as names, company affiliations, and specific project references, is removed. This anonymized transcript is used for all subsequent analysis.
3. **Uploading Data to ATLAS.ti:** The cleaned and edited transcription is uploaded into ATLAS.ti, a qualitative data analysis software.
4. **Thematic segmentation**: The transcript is segmented thematically by dividing it into sections that correspond to the recommendations for action from phase 1. This makes it easier to assign statements and opinions to specific questions.
5. **Analysis**: The data is evaluated and used to identify key statements such as consensus, differences and additions. If new topics emerge, the recommendations are expanded accordingly.
6. **Comparison and integration**: The results of the focus group are compared with the findings from the interviews. This process involves checking which recommendations for action should be confirmed, adapted or expanded, and whether new aspects can be included. The aim is to validate and further develop the recommendations.
7. **Summarizing and prioritizing**: The key findings of the focus group are summarized and the recommendations for action are prioritized. The results are directly incorporated into the further development of the recommendations to make them practical and targeted.
8. **Translation:** Since the focus group workshop was conducted in German, the final transcription and findings are translated into English after the interpretation phase. This ensures consistency and facilitates the integration of results into broader academic and professional discourse.

3.3 Combining the Results: Empirical Analysis, Focus Group, and Literature Integration

A triangulation method was applied to consolidate and validate the research findings by integrating data from the in-depth qualitative analysis of project developers' practices, the focus group workshop, and the review of existing literature. This approach involves comparing practical insights gathered from project developers (phase 1) with expert feedback (phase 2) and existing studies on circular economy and real estate development. By connecting these three layers, the

study establishes a robust foundation for understanding the integration of circular principles into project selection.

The empirical data collected during phase 1 provides a detailed view of current practices and challenges, while phase 2 offers insights and a review of the derived recommendation for action, contextualizing these findings within broader trends and advanced frameworks. Meanwhile, the review of previous studies serves as a benchmark, ensuring that the research findings align with or critically evaluate established knowledge.

The objectives of this combined analysis are threefold:

- Identify Patterns: Uncover consistent themes and best practices in applying circular principles across project selection processes.
- Bridge Gaps: Recognize variations or barriers in practice that differ from theoretical approaches, highlighting areas for further development or intervention.
- Innovate: Draw upon expert insights and literature to propose innovative strategies that address identified gaps and enhance circularity.

By synthesizing these elements, the research develops a comprehensive framework for circular project selection. This approach validates theoretical propositions through practical examples, while expert feedback ensures the recommendations are actionable and aligned with cutting-edge developments in the field. The resulting framework bridges the gap between literature and practice, offering a pathway for project developers to incorporate circular economy principles more effectively in real estate transformation projects.

4. Findings from phase 1: Semi-structured interviews

This chapter deals with the systematic processing and evaluation of the interview data and the derivation of recommendations for action. In 4.1, the interview data is analyzed by coding and grouping it to identify patterns and thematic focuses. On this basis, 4.2 derives specific recommendations for action that arise from the previously developed themes and serve as practical guidelines.

4.1 Codes and Grouping

As part of the present study, the transcripts of the interviews conducted were subjected to systematic coding. The aim of this step was to work out central themes, patterns and correlations from the qualitative data to create a sound basis for the analysis. A structured coding approach was used, which made it possible to transfer the interviewees' statements into meaningful categories.

In total, the coding resulted in 114 individual codes that emerged from the data analysis. To reduce the complexity of the data and ensure a clear structure, the identified codes were bundled into five themes. These themes reflect the key themes of the study and serve as the basis for further analysis:

1. Economic Feasibility & Added Value
2. Projects Analysis
3. People & Knowledge
4. Technology & Innovation
5. External Factors & Drivers

Within each theme, the codes were further categorized into sub-themes, providing an additional layer of organization. This grouping allowed for a more nuanced understanding of the data by clustering related codes under specific sub-themes. These sub-themes serve as a structured framework to develop actionable recommendations in a logical and prioritized sequence during the next phase of the study.

Table 5 shows the ranking of the themes, and the sub-themes within, according to the number of quotations that either directly or indirectly addressed the aspects. Each sub-theme is underlined by an example quotation. A full list of the codes within each sub-theme can be found in Appendix V.

Table 5: Weightage of themes and second order themes based on semi-structured interviews from ATLAS.ti

Ranking	Themes (no. of quotations / 336)	Sub-themes (no. of quotations / 336)	Example quotation
1	Economic feasibility & added value (121)	Costs (79)	*"[…] there is […] a major economic efficiency parameter […] a tension between how much money would have to be invested to convert the space in such a way that it meets a rental and sales expectation?"*
		Income (55)	*"Our tenants […] like the idea of circularity, but none of them are willing to pay even a single euro more in rent."*
		Financing (40)	*"If we don't transform the buildings, […] you won't get any financing […] or*

			large tenants won't be interested in renting in such a building."
		Risk (32)	*"Lower vacancy rates can also be seen in the fact that I simply rent out such space faster."*
		Taxes & subsidies (17)	*"We have to look at the framework conditions of the future and […] what the world will look like then […], topics such as CO_2 tax or demolition permits […] can be crucial in the future."*
2	Project Analysis (104)	Accurate & transparent Data Management (57)	*"If I buy something as an investor, I want to have as much information as possible about this object."*
		Supplementary Analysis (45)	*"In this quick check, I would ultimately like to see from the engineering firms […] what percentage of the individual components and plant groups I can still add to the circularity, which cannot, and then make the decision whether I will have to build a new one […] this preparatory work […] should also be included."*
		Early Integration of Circularity (36)	*"The earlier stages are the key phase to implement circularity, because the more advanced you are in the project, the more difficult it gets to implement those strategies."*
		Preselection criteria (19)	"The worst buildings are those from the 1970s. […] After that, buildings were built better, and the very old buildings before that are also good again."
		Comparative Analysis (14)	*"And if there is existing stock, then we have the approach of offering parallel concepts […] to maintain the existing and to plan a new building at some point in order to compare the two."*
3	People & Knowledge (90)	Corporate culture (46)	*"But also that the topic of circularity is made clear to the project team from the outset. […] that we are doing this and that everyone is pulling in the same direction."*
		Knowledge sharing (38)	*"A good combination of the young generation and experienced generations […] so that knowledge is shared, but also so that the experienced generation understands what the young generation is thinking or where it is coming from."*
		Expert Knowledge (29)	*"So if you implement it yourself, you need a specialist planner who is familiar with it […] the early involvement of the relevant specialist*

			planners in the implementation [...] it is becoming more and more complex and it cannot be done by one person alone, nor by an architectural firm, they have completely different issues that are relevant there."
		Training & Education (26)	*"We notice that somehow there are often still question marks behind it, because then the basis is not perfect, but [...] there are interfaces where many say, yes, but new would be easier [...] more understanding and support in the processes, that would be great."*
4	Technology & Innovation (88)	Added components (63)	*"When we use new facades, it's important that they are facades that promote the concept of circularity [...] the elements can be reasonably disassembled at the end of their service life and added to a cycle in some form."*
		Fragmented Understanding (53)	"*We as project developers then try to bring the topic [of circularity] to the agenda, but as I said, I think it is mainly in new construction at the moment."*
5	External factors & drivers (59)	Regulations & EU Taxonomy (49)	*"If it becomes an obligation because you are affected by some kind of regulation that we have to comply with and then just have to prove it, then these requirements go straight to us and then we just implement it accordingly 1 to 1."*
		Certifications (14)	*"Quite often we have projects where certification is to be carried out. But in my opinion that is not enough [...] it is better to achieve more than what can be achieved with certification [...] to be open to the goals [about circularity]."*
		Requirements of architectural firms (2)	*"If the project has no sustainability ambitions whatsoever, then it's not a project that we [Architects] are interested in."*
		Insurance (1)	*"Meanwhile, the issue of insuring buildings has also become a very important topic. Due to all the heavy rainfall events, flood disasters and so on, there are simply regions where insurance companies simply no longer insure buildings [without sustainable and circular goals]."*

4.2 Strategy (Framework) Synthesis

In the next step, the interview findings and data analysis will be used to develop recommendations for project developers that include the integration of circularity into the project selection process.

4.2.1 Economic Feasibility & Added Value

As EXP8 states: *"Circularity is the perfect link between economical sustainability and environmental sustainability."* Despite this potential synergy, many experts are critical of the economic viability of circular approaches in project development. Particularly when selecting projects, the question arises as to how circular principles can be economically evaluated and meaningfully integrated into decision-making processes. This chapter presents the findings according to some of the economic factors identified in the literature review – costs, revenue, taxes, risks and financing – and the added sub-theme taxes & subsidies. Based on these specific recommendations for project evaluation and selection were developed.

Costs

During the interviews, it became clear that experts disagree on whether circular construction is more expensive than conventional construction methods or whether it can be made cost-neutral or cost-saving through targeted measures. While some experts emphasize the potential for additional costs, others point out the possibility of achieving long-term savings. Some experts argue that circular construction can initially be more expensive than traditional construction methods. This is mainly due to higher material costs, additional planning requirements and new processes. EXP3 explains:

> "Unfortunately, many products are still more expensive than the standard. If I want to take circularity into account, some products unfortunately fall away in the process."

However, there are experts who think that costs can be significantly reduced through clever planning and innovative approaches. EXP1 emphasizes the importance of material recovery:

> "If I have high-quality materials that I can get out again, then they have a positive value."

Using such materials a second time not only enables savings but also increases the long-term value of the building. In addition, some experts emphasize that significant costs can be saved by preserving existing structures, especially load-bearing structures, windows or facades. EXP6 explains:

> "Reuse the structure of a building in any case [...] this contributes to cost reduction."

These approaches underline that the openness of the project developer who calculates the feasibility of a project and their willingness to include innovative models such as material recycling and reuse in the calculation is crucial. A key advantage of circular projects lies in the reduction of operating costs. These results from the longevity of the materials used and the energy efficiency of the buildings. EXP1 emphasizes:

> "I save money in operation. There are many, many factors."

However, these savings are often difficult to quantify because they only become visible over the entire lifespan of a building. A life cycle analysis (LCA) is therefore essential to take long-term cost savings through circular measures into account as early as the project selection stage.

Recommendations for action:

1. Life cycle analysis (LCA) as a basis for decisions: Project developers should integrate a standardized LCA into project selection to take long-term costs and savings into account. This analysis should include both operating costs and potential material values and reuse potential.

2. Evaluate reusable materials: The recovery of high-quality materials and their reuse should be included as a fixed component in the cost calculation. Tools such as Madaster can help to document the material value of a building and make it transparent.

Income

Experts disagree on whether sustainable and circular construction methods can generate higher rental yields or sales prices. While some experts point out that circular real estate is explicitly in demand and that higher rents and yields can be realized as a result, others emphasize the uncertainties in renting and the lack of concrete evidence of increased revenues. A key point in the discussion about circular real estate is the increased demand for such projects, particularly from a demanding tenant clientele. The experts describe this development:

> "There is explicit demand for this type of real estate [sustainable / circular], and you can also see that it has a higher value, in terms of prices and rents, which are extremely higher than the neighboring building, which is perhaps more conventional." (EXP1)
>
> "Our tenants [...] like the idea of [circularity], but none of them are willing to pay even a single euro more in rent." (EXP5)

This trend could indicate that circular projects are an attractive option for tenants who value sustainable and innovative concepts. In particular, large companies that are required to regularly publish sustainability reports are actively seeking buildings that meet their ESG criteria. This targeted demand could enable an increase in rental expectations for circular projects. Although experts disagree on whether circular projects can command higher rents, they agree that such buildings offer greater security of tenancy due to their sustainability features, thus significantly reducing the risk of vacancy rates.

Recommendations for action:

1. Do not have unrealistic expectations of higher rental income or sale prices: It is not recommended to assume higher rental income or an increased sales value through circular construction methods across the board in the profitability assessment. Expert opinions on this are too inconsistent, and the tenants' willingness to pay depends heavily on individual preferences, location and the type of building. A cautious and realistic approach to the valuation of income is therefore advisable.

Financing

In today's real estate industry, many banks and investors already require sustainability and circularity as a prerequisite for financing a project. This shows that circular building transformations are not only ecologically but also economically forward-looking. EXP3 emphasizes the increasing importance of circularity for financing decisions:

> "For us who are transforming, it will always be the case that it is a standard that I simply have to implement because the banks will demand it, because investors will demand it."

For project developers, this means that circular approaches could no longer be optional, but increasingly necessary to gain access to financing. The integration of sustainability and circularity criteria can thus have a decisive influence on the feasibility of a project. Another advantage of

circular projects lies in their potential increase in value when considered as material banks, which is a storage system for construction materials salvaged from decommissioned buildings, whether through redevelopment, demolition, or other processes. Projects that contain high-quality and reusable materials can be better valued in financing negotiations. EXP1 describes this approach as follows:

> "If I build in a circular way and can reintroduce a building material into the cycle, then it has a higher material value."

Such projects can be shown as assets on the balance sheet, which can lead to more favorable financing conditions, such as lower interest rates. EXP1 adds:

> "By demonstrating circularity and material value, the bank offered more favorable conditions. They said you can account for that because you have a material bank."

For project developers, it therefore makes sense to document the material value of a building at an early stage and present it to financing institutions. This can not only facilitate access to financing but also increase the long-term value of the property. The possibility of better selling circular projects in terms of tax and accounting opens further financing options. EXP7 mentions:

> "The presence of a building resource passport could improve the depreciation of the building."

This suggests that a clearly documented material value can be used not only for banks evaluations but also for interest payment advantages. By accurately capturing material resources and their potential reuse, depreciation models can be adapted in the long term that increase the financial attractiveness of such projects.

Recommendations for action:

1. Integrate financing requirements into the profitability calculation: When selecting projects, project developers should consider the financing requirements of banks and investors from the outset. Projects that meet sustainability and circularity criteria offer better chances of achieving better conditions, such as lower interest rates or a higher valuation of the property. These potential benefits should be reflected in the calculation by making appropriate assumptions to enable a realistic assessment of profitability.

2. Include material value and building resource passport as calculative advantages: Preference should be given to projects with a clearly documented material value and the potential for a building resource passport. These aspects can lead to better financing, for example through depreciation, advantages or the recognition of the material value as an accounting advantage. The possibility of considering materials as resource stores should be considered at the project selection stage.

Risks

A key risk factor is the probability of space being rented. In particular, large companies that are required to regularly publish sustainability reports actively seek out buildings that meet their ESG (Environmental, Social, Governance) criteria. EXP3 describes:

> "Tenants are making leasing decisions based on how sustainable [and circular] a property is."

This offers developers the opportunity to set the probability of long-term vacancies lower in circular projects in the risk assessment. The attractiveness of circular buildings for prospective tenants significantly reduces the risk of vacancies. EXP1 confirms:

> "Lower vacancy rates can also be seen in the fact that I simply rent out such space faster."

Although experts disagree on whether circular projects can command higher rents, there is consensus that such buildings offer greater security of tenure. Therefore, a more optimistic but realistic vacancy rate could be applied in the risk assessment, which would have a positive impact on profitability calculations. Another factor that should be included in the risk assessment is the building permit. Experts agree that circular transformations of existing buildings are often preferred by building authorities because they are more sustainable and resource-efficient than new buildings. EXP1 explains:

> "The more sustainably I build, the easier it is to get a permit."

However, the high requirements for verification of existing components represent a counterargument. EXP4 describes:

> "It is very difficult to get approvals because the verification process for existing components is complex."

Nevertheless, it is generally assumed that the probability of obtaining approval is higher for building transformation projects, which should be considered an advantage in project selection.

Recommendations for action:

1. Adjust vacancy rates conservatively: Since circular and sustainable buildings are particularly attractive to larger companies that must meet ESG criteria, the vacancy rate should be set optimistically but realistically in risk assessment. This reduces the perceived risk and strengthens the profitability calculations.
2. Analyze approval risk: Preference should be given to circular projects because they are more likely to receive a building permit. At the same time, it is necessary to consider the requirements of verification management at an early stage and to establish internal processes for documenting components.

Taxes & Subsidies

No specific statements were made in the interviews regarding taxes that would be directly applicable to the selection of circular building projects. In principle, there is currently no specific tax incentive or relief for circular construction projects in Germany. However, some experts mentioned the potential impact of the CO_2 tax expected in the future. This tax could particularly increase the advantage of projects that cause fewer emissions by saving grey energy. EXP4, for example, noted that future conditions must be considered when considering profitability:

> "We have to look at the framework conditions of the future and [...] what the world will look like then [...], topics such as CO_2 tax or demolition permits [...] can be crucial in the future."

Government funding programs play an important role in financing circular projects, but opinions among experts on their efficacy vary. On the one hand, subsidies are seen as crucial support for enabling the transformation into circular approaches. As EXP7 explains:

> "Of course, subsidies are very, very important because it simply helps to manage this transformation process."

On the other hand, critical voices highlight the challenges associated with subsidies. EXP3 warns:

> “I'm not a big fan of always saying, you'll get a subsidy, so do it, either, because often, when you do the math, I have more internal costs that have to deal with the issue of funding than I do of the extra money I get for it.”

These critiques underline the administrative burden and uncertainty involved in applying for funding. Similarly, EXP9 stresses the risks of relying on subsidies:

> “It is too risky to include subsidies in the calculation because receipt is not guaranteed.”

To address these challenges, it is recommended that companies include subsidies in their financial calculations but with a conservative assessment of the probability of receipt. This ensures that the risk of not receiving the funding is quantified and accounted for in the overall profitability analysis. Furthermore, companies should develop strategies to streamline internal processes and reduce the administrative effort required to apply for and manage subsidies.

Recommendations for action:

1. Consider long-term perspectives: Even though there is currently no carbon tax in Germany, project developers should take possible future developments into account in their decisions. A cautious scenario analysis could help to quantify the potential savings from circular measures if a carbon tax were introduced. However, these considerations should not be the basis for current investment decisions but should only be included in the risk assessment as a supplementary factor.
2. Monitor political developments: It is essential to continuously monitor tax and political conditions to be able to react to new tax adjustments at an early stage. Systematic monitoring of such developments could help project developers to identify advantages in good time and adjust their strategies if necessary.
3. Develop strategies for getting subsidies: Subsidies should be considered in project evaluations, but companies must optimize internal workflows to minimize administrative burdens and costs associated with funding applications.
4. Assess subsidies with risk: Subsidies should be included in financial calculations with a probability of occurrence to minimize financial uncertainty and create a realistic foundation for project selection.

In conclusion, considering the economic viability of circular measures depends to a large extent on the perspective and conviction of the people or teams doing the calculations. The willingness to evaluate circular aspects positively is often closely linked to the attitude of the company or the actors involved. As EXP6 aptly puts it:

> “The necessity [...] to sharpen that this is really being addressed and that the maxim of making money is not at the top, but rather saying OK, I just don't make 10 but only 8% [revenue], then it's okay.”

This underlines the importance of a long-term ideology that understands circularity as integral components of economic decisions and is not focused solely on short-term profits.

4.2.2 Project analysis

Project analysis plays a crucial role in determining the feasibility and success of circular building transformations. While the literature highlights numerous types of analyses and parameters that could be used to evaluate such projects, which were listed in 2.2.2, it becomes evident that

conducting all these assessments is not economically viable. Through the analysis of interview data, this chapter identifies the most critical analyses and criteria, providing a focused approach to support project developers in integrating circularity into their selection processes. Specifically, this chapter addresses key areas such as the importance of data management, the need for supplementary and innovative assessment methods, the early integration of circularity into project processes, the role of preselection criteria like location and building age, and the comparison of circular transformations versus new construction. These themes collectively offer practical insights for aligning project analysis with the principles of circularity.

Accurate and transparent data management

Data and documentation play an increasingly important role in the evaluation, planning and subsequent marketing of projects. It is essential that information such as material composition, dismantlability and reusability is recorded accurately and transparently. EXP7 emphasized:

> "The knowledge we have about components will be quite valuable in the end and is becoming increasingly important."

The use of digital tools such as BIM (Building Information Modelling) models or material databases can help to standardize processes and increase efficiency. EXP9 explained:

> "It always comes down to the quality of the data and also the quality of the planning and the research [...]. It would be great if insights could be easily transferred in databases."

Recommendation for action: Companies should use digital tools and databases to systematically collect and manage information. The quality of the data not only influences the success of the project but also increases the future value of a property.

Supplementary Analysis

The interviews make it clear that traditional inspection approaches such as due diligence (DD) and technical due diligence (TDD) are not sufficient to fully cover the requirements of a circular project transformation. Supplementary analyses such as a review of the statics, logistics and disposal options were highlighted as essential. EXP1 made it clear that comprehensive information about a building is crucial:

> "When I buy something as an investor [or developer], I want to have as much information as possible about this property [...]. Take asbestos, for example – many existing buildings are contaminated, so that's a huge cost issue."

In addition, the integration of ESG due diligence (ESG-DD) was discussed in the interviews as an extension of the existing audits. EXP3 emphasized that ESG DDs, combined with traditional TDDs, can enable a more detailed assessment of a building's sustainability and circularity aspects:

> "But it also goes so far as to mean that we now carry out an ESG DD (ESG due diligence) for every acquisition [...] in combination with a TDD, and that's where we scan the property to see what it can and can't do yet."

Another innovative approach was presented by EXP2: the "Quick Check". This approach involves engineering firms conducting systematic analyses at an early stage to assess the condition of the building and the potential for circularity. EXP2 explained:

> "What I would like to see in this Quick Check [...] is a pie chart that shows me the percentage of each component and system group that I can still add to the circular economy, which I

> cannot, and then decide whether I will have to build a new one, whether I will be able to carry out a partial transformation or almost 100% circularity."

Combining these approaches provides project developers with a comprehensive basis for making informed decisions. The Quick Check highlights in particular which components can be reused or recycled, while the ESG-DD systematizes the sustainability assessment and supports the integration of circularity.

Recommendation for action: Project developers should integrate supplementary assessment methods such as the Quick Check and the ESG-DD into their selection processes as standard. While the Quick Check provides a detailed analysis of the circularity potential of individual components, the ESG-DD offers a comprehensive framework for assessing the ecological, social and economic sustainability of a project. Together, they provide a solid foundation for strategic decisions that promote both ecological and economic benefits.

Early integration of circularity

The interviews showed clear agreement that circularity should be integrated into the project process as early as possible. The early phases of a project – especially phases 0 and 1 – offer the greatest leverage for implementing circularity approaches. EXP7 emphasized:

> "The earlier the better, because anything you define early [...] has a significantly higher probability of survival."

By contrast, later changes are often cost-intensive and associated with significant restrictions. EXP8 added:

> "The earlier stages are the key phase to implement circularity, because the more advanced you are in the project, the more difficult it gets to implement those strategies."

Recommendation for action: Companies should define circularity as an integral part of the early planning phases. This requires the early definition of objectives that are consistently incorporated into the further planning and decision-making process.

Preselection criteria

The location of a property and its year of construction were repeatedly mentioned as essential factors for evaluating projects suitable for a circular transformation. A central location not only increases the attractiveness in terms of sales and rental potential and also facilitates logistical opportunities such as the supply of materials. EXP5 emphasized:

> "Location, location, location, so location is, I think, the key issue."

In addition, the year of construction of the building plays an important role. Older buildings from certain construction phases, such as before 1970 or after the 1990s, often offer more stable building materials and higher-quality materials. In contrast, buildings from the 1970s often require extensive renovation work due to their poor energy and structural quality, as EXP6 explained:

> "The worst buildings are those from the 1970s. [...] After that, buildings were built better, and the very old buildings before that are also good again."

Recommendation for action: Companies should systematically integrate location and year of construction into the first phase of project evaluation. It is crucial to consider not only economic aspects, but also regional characteristics and potential restrictions, such as pollution or logistical challenges, at an early stage.

Comparative Analysis

A systematic comparison of transformation versus new construction was identified as crucial for informed decisions. Parallel concepts, where one version analyses a potential transformation of the building versus the second version analyzes a new building on the site instead. This enables the comparison of the possibilities of circular transformation and new construction and enables a differentiated assessment of the ecological and economic impacts. EXP4 explained:

> "We are investigating the option of refurbishing and then planning a new building in order to compare the two."

The integration of a life cycle assessment (LCA) extends this approach by considering the entire lifespan of a project and provides important data for a sustainable decision. EXP2 explained:

> "You can quickly get to the point of whether circularity is really the solution [...] Then make the decision: Will I need to rebuild or be able to carry out a partial transformation?"

Recommendation for action: The systematic investigation of several variants, supplemented by a life cycle analysis, should be established as a standard process in the design phase. This enables well-founded and long-term sustainable decisions that offer both ecological and economic advantages.

4.2.3 People & Knowledge

At the heart of project selection processes are people - individuals shaped by their experiences, knowledge, and collaboration with others. Integrating circularity into real estate project selection requires more than technical expertise; it demands a collective effort where diverse perspectives are brought together to make informed decisions. This chapter explores how intergenerational knowledge sharing, continuous training, and expert involvement can drive the adoption of circularity principles. Additionally, it examines the role of corporate culture in embedding circularity as a fundamental value, ensuring that human interaction and organizational dynamics align with sustainable decision-making.

Corporate culture

A sustainable corporate culture is essential to anchoring circularity not only at the project level but also at the strategic level. Companies should define circularity as part of their corporate social responsibility (CSR) and incorporate this philosophy into decision-making processes and working methods. EXP1 described the importance of such a strategy:

> "It is also important for project developers to have a long-term sustainable portfolio. After all, this also reflects the identity of a company."

Recommendation for action: A consistent corporate strategy that establishes circularity as a guiding principle not only enables more effective implementation in projects but also strengthens the company's image in the eyes of investors, customers and employees.

Knowledge sharing

A crucial factor for the successful implementation of circularity principles is the exchange between experienced and younger generations. While the older generation can draw on in-depth practical knowledge and extensive experience in project development, the younger generation brings new ways of thinking and a fundamental understanding of circularity. This knowledge has been increasingly taught at universities in recent years, as EXP1 emphasized:

> "There are extra courses for sustainable construction [...] it should be a standard compulsory subject, because that's what matters [...]."

The exchange of knowledge between generations offers a valuable opportunity to broaden perspectives and develop innovative approaches. One expert formulated this thought succinctly:

> "A good combination of young and experienced generations, so that knowledge is shared, but also so that the experienced generation hears what the young generation is thinking and how they approach things." (EXP2)

This approach not only promotes an understanding of circularity but also creates a social benefit where a dynamic work culture strengthens both generations.

Recommendation for action: Project teams should consciously be put together by people of both younger and older generations. The older generation brings valuable practical experience and in-depth knowledge of project development, while the younger generation brings innovative approaches and a fundamental understanding of sustainability. This combination makes it possible to integrate circularity principles more comprehensively and effectively into the project selection process.

Expert Knowledge

The interviews highlight the central importance of interdisciplinary collaboration and the early involvement of experts to successfully integrate circularity. It was emphasized several times that circularity cannot be implemented by architects or engineers alone. Rather, it requires close cooperation between specialist planners, consultants, research institutions and other relevant stakeholders. EXP1 emphasized the need for specialized expertise:

> "You need technical expertise, whether it's the right planners or consultants to provide support here."

EXP2 added that building networks and actively exchanging ideas with other market players is crucial to sharing knowledge and learning from each other:

> "I think you always have to be in touch with a lot of players in the market [...] Rather be a first follower, then I think you can position yourself very, very strongly."

At the same time, it became clear from the interviews that the market and knowledge about circularity are developing dynamically. It is therefore unrealistic to expect project developers to always stay up to date with the latest developments alongside their day-to-day work. This is where experts play a crucial role. Two approaches for integrating such expertise were highlighted:

1. Internal teams for sustainability and circularity: Setting up internal departments or groups that work directly with project teams enables quick, iterative decisions and the immediate integration of circularity principles. EXP4 described the advantages of this structure:

> "We set up an internal group for sustainable planning 5 years ago [...] because we realized that our way of working in the concept phase is quite fast and if you only do it through external parties, it sometimes doesn't go fast enough."

2. Collaboration with external experts: External consultants contribute specialized knowledge and current insights from research and universities, which is particularly advantageous in highly dynamic subject areas such as circularity. EXP8 emphasized:

> "It is also important to work with the right experts and to study the various possibilities, because what you initially consider to be sustainable sometimes is not."

Recommendation for action: Companies should use both internal and external expertise to effectively implement circularity principles. Internal teams ensure quick decision-making processes and are ideal for iterative project development. External consultants, on the other hand, supplement knowledge with the latest scientific findings and best practices. In addition, regular conferences, workshops and joint projects can promote exchange within networks and strengthen interdisciplinary collaboration.

Training and education

In view of the increasing complexity of projects and the dynamics of the market, it is essential that project developers receive continuous training and further education. A basic understanding of circularity can help to identify opportunities and adapt strategic decisions accordingly. As EXP9 noted, there is often a deficit of specific knowledge that could be compensated for by targeted training measures:

> "We realize that there are often still some question marks because the basis is not perfect, but somehow there are always interfaces where many people say, yes, but it would be easier now, so maybe more understanding and support in the processes, that would be great."

Recommendation for action: Training should not only be offered voluntarily but considered an integral part of professional development. This ensures that all parties involved have the necessary knowledge to effectively incorporate circularity into the selection process.

4.2.4 Technology and Innovation

The interviews with experts revealed diverse perspectives and challenges shaping the industry's approach to circularity. During the analysis, particular attention was paid to identifying practices, technologies, and measures that experts consider important and promising for the future of circularity. Additionally, the analysis highlighted areas where certain prejudices or misconceptions persist within specific aspects of circularity, offering insights into potential barriers and opportunities for broader adoption.

Added components

The integration of circular materials and innovative construction methods offers a significant lever for promoting circularity when adding materials or building components - such as modular extensions, façade elements, interior partitions, or structural reinforcements - to a building transformation. It is essential to consider circular materials as early as the "project idea and conception" phase. Technologies such as material passports and databases, such as Concular or Madasta, can play a central role here in evaluating the value and reusability of building materials at an early stage. In addition, the importance of timber construction and modular components was emphasized, which not only saves CO_2 but also promotes the disassembly and reuse of materials. EXP7 emphasized:

> "We then supplement the extensions in timber construction because we are trying to save as much CO_2 as possible there."

Another innovative approach is the "Product as a Service" concept, in which manufacturers remain responsible for the maintenance and reuse of their products. This creates incentives for durable and reusable materials, as noted by EXP7:

> "[...] how the manufacturer then implements [Product as a Service] is their business, and after this period of use, the whole thing is returned and recycled in the best case."

Recommendation for action: Integrate innovative materials and technologies at an early stage: Project developers should prioritize the use of circular materials as early as the design phase and use tools such as material passports to conduct a thorough assessment of existing and new materials. Timber construction, modular components, and the "product as a service" concept should be included as strategic options in project selection. Training and exchange with manufacturers can help to implement these approaches efficiently.

Fragmented Understanding

A central theme in the interviews was the tendency to consider circularity primarily in new construction or through small-scale measures. Many project developers associate circularity primarily with the use of circular technologies in new construction, as they see more potential for value creation and environmentally beneficial impact there. EXP7 noted:

> "We as project developers then try to bring the topic [of circularity] to the agenda, but as I said, I think it is mainly in new construction at the moment."

Furthermore, circularity is often reduced to individual measures, such as the reuse of facades or surfaces, instead of viewing it as a holistic transformation concept for existing buildings. EXP9 emphasized:

> "It always depends [...] on the investigation and that you really have to think about circularity holistically."

Another challenge is the excessive focus on energy efficiency. While the transformation of energy sources is an important aspect, circularity should go beyond that and address material cycles. EXP3 explained:

> "I believe that a lot of people are riding on the topic of CO_2 right now [...]. I think that this shifts the issue of environmental damage caused by the construction industry and existing buildings to the energy sector [...], but the more we detach ourselves from the CO_2 consideration, the more we realize how much we are wasting resources. We are simply getting closer and closer to the point where resource scarcity will be addressed, and in this respect, the topic of circularity will gain significant momentum."

Recommendation for action: Training and awareness raising for holistic approaches: Project teams should be trained to broaden their horizons beyond conventional associations such as new construction and individual measures. Consideration of opportunities in large-scale transformations of existing properties should be encouraged, as should a holistic understanding of circularity that includes material cycles, dismantlability and resource conservation.

4.2.5 External factors and drivers

The expert interviews have made it clear that many external factors and drivers are influencing the development of the real estate industry and are becoming increasingly important. For project developers, it is essential to actively monitor these developments and integrate them into their strategies and projects to remain economically successful in the long term. This chapter explores four key topics identified by experts as critical for the future - the impact of regulations and the EU taxonomy, the role and limitations of certifications, evolving requirements from architectural firms, and the emerging influence of insurance companies. By addressing these factors, this

chapter highlights how external drivers can shape the adoption of circularity and sustainability within the industry while offering insights for proactive strategy development.

Regulations and EU taxonomy

The EU taxonomy and other regulations are increasingly tightening the requirements for sustainability and circularity. The experts emphasized that compliance with these requirements is not only necessary to ensure regulatory compliance, but also essential to remain economically competitive. EXP3 emphasized the importance of regulatory requirements:

> "If it becomes an obligation because you are affected by some kind of regulation that we have to comply with and then just have to prove it, then these requirements go straight to us and then we just implement it accordingly 1 to 1."

The increasing importance of such regulations shows that project developers should take appropriate measures at an early stage. This includes, for example, integrating circularity standards into the planning process and taking into account potential future requirements.

Recommendation for action: Developers should proactively monitor developments in regulation and the EU taxonomy and take early action to ensure compliance with these standards. This includes the introduction of assessment tools such as material passports and the integration of circularity principles into all project phases.

Certifications

Certifications such as DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) or LEED (Leadership in Energy and Environmental Design) play an increasingly important role, both in real estate valuation and as a marketing tool. However, some experts expressed skepticism about their actual effectiveness. EXP3 explained:

> "We need a sustainability story for every building, otherwise we won't get financing, investors or tenants. But with certificates like LEED, I don't have the feeling that much has been done in the direction of circularity."

Other experts, such as EXP8, have criticized the fact that certificates often do not address the specific requirements of a project and therefore do not necessarily promote actual sustainability. Nevertheless, they are increasingly playing a role in the perception of investors and tenants.

Recommendation for action: Although certifications should be considered, as they are often required by investors and banks, it is essential not to lose sight of the actual sustainability and circularity of a project. Developers should ensure that certificates are not just used as a marketing tool but reflect the actual quality and circularity of a project.

Requirements of architectural firms

Some experts reported that architectural firms are increasingly specializing in projects with a clear focus on sustainability and circularity and rejecting other commissions. This change illustrates that sustainable projects are increasingly in demand not only from investors and tenants, but also from architects. EXP8 emphasized this development:

> "If the project has no sustainability ambitions whatsoever, then it's not a project that we [Architects] are interested in."

This development shows that there will also be a change in thinking in the long term when working with architects. Projects that do not have clear sustainability goals may find it more difficult to attract the best partners.

Recommendation for action: Developers should ensure at an early stage that their projects define sustainability and circularity goals to appeal to architectural firms and other planning participants who are increasingly making such demands.

Insurance

One factor that has not been found in the study of literature so far is the role of insurance companies. According to EXP3, some insurers are beginning to impose requirements for circularity and sustainability to insure buildings:

> "Meanwhile, the issue of insuring buildings has also become a very important topic. Due to all the heavy rainfall events, flood disasters and so on, there are simply regions where insurance companies simply no longer insure buildings [without sustainable and circular goals]."

This point could become more important in the future as climate risks and the sustainability requirements of insurance companies increase. This could not only influence the insurance market but also align project development more closely with circularity.

Recommendation for action: Project developers should include insurance requirements as a new factor in their project assessments. Early coordination with insurance companies can help to minimize future risks and ensure insurability.

4.2.6 Summary of recommendations for action

List of Recommendations for Integrating Circularity into Project Selection:

Economic Feasibility & Added Value

Costs

1.1 Life cycle analysis as a basis for decisions: Project developers should integrate a standardized LCA into project selection to take long-term costs and savings into account. This analysis should include both operating costs and potential material values and reuse potential.

1.2 Evaluate reusable materials: The recovery of high-quality materials and their reuse should be included as a fixed component in the cost calculation. Tools such as Madaster can help to document the material value of a building and make it transparent.

Income

1.3 Do not have unrealistic expectations of higher rental income: Avoid assuming universally higher rents or sales values from circular construction methods. Assess these conservatively, as tenant preferences depend heavily on location, building type, and individual needs.

Financing

1.4 Integrate financing requirements into the profitability calculation: Reflect circularity and sustainability criteria in financial planning to improve financing conditions, such as lower interest rates or higher property valuations.

1.5 Include material value and building resource passport as calculative advantages: Document and leverage material value and resource passports to gain financial benefits, such as depreciation advantages or recognition of materials as assets.

Risks

1.6 Adjust vacancy rates conservatively: Set realistic vacancy expectations for circular buildings, considering their attractiveness to ESG-driven tenants.
1.7 Analyze approval risk: Favor circular projects likely to secure permits and prepare for verification requirements early by establishing robust internal processes.

Taxes & Subsidies

1.8 Consider long-term perspectives: Factor in potential future taxes, such as a carbon tax, in risk assessments while ensuring they are not the sole basis for decisions.
1.9 Monitor political developments: Stay informed on changes in tax and political frameworks to adjust strategies proactively.
1.10 Develop strategies for getting subsidies: Streamline internal workflows to reduce the administrative burden of applying for and managing subsidies.
1.11 Assess subsidies with risk: Include subsidies in financial calculations with a conservative probability of receipt to minimize financial uncertainty.

Project Analysis

2.1 Accurate and transparent data management: Use digital tools and databases to systematically document and manage information such as material composition, dismantlability, and reusability.
2.2 Supplementary analysis: Incorporate Quick Checks and ESG-DDs into project selection processes to evaluate circularity potential and sustainability comprehensively.
2.3 Early integration of circularity: Embed circularity principles in the initial planning phases to maximize their effectiveness and feasibility.
2.4 Preselection criteria: Factor in location and building age early in project evaluation, considering economic aspects, pollution risks, and logistical challenges.
2.5 Comparative analysis: Use systematic variant analysis, supplemented by LCAs, to compare the ecological and economic impacts of circular transformation and new construction.

People & Knowledge

3.1 Corporate culture: Establish circularity as a core organizational value to strengthen project implementation and the company’s image with stakeholders.
3.2 Knowledge sharing: Combine the experience of older generations with the innovative perspectives of younger ones to effectively integrate circularity principles into project selection.
3.3 Expert knowledge: Leverage both internal teams for quick decisions and external experts for cutting-edge insights and best practices.
3.4 Training and education: Make circularity training a mandatory part of professional development to ensure stakeholders have the necessary knowledge and skills.

Technology & Innovation

4.1 Adress circularity for added components: Prioritize circular materials and strategies such as timber construction, modularity, and "product as a service" in early project stages. Tools like material passports should be used for assessing existing and new materials.
4.2 Training and awareness raising for holistic approaches: Encourage project teams to adopt comprehensive perspectives that include material cycles, resource conservation, and dismantlability.

External Factors & Drivers

5.1 Regulations and EU Taxonomy: Monitor regulatory developments, such as the EU Taxonomy, and integrate tools like material passports early to ensure compliance.

5.2 Certification: Use certifications to reflect genuine sustainability and circularity, rather than solely as marketing tools.

5.3 Requirements of architectural firms: Define circularity goals early to meet rising expectations from architects and other planning stakeholders.

5.4 Insurance: Incorporate insurance requirements into project assessments to minimize risks and ensure insurability.

5. Findings from Phase 2: Focus Group

In the second phase of the empirical study, a focus group workshop was conducted with seven experts to validate and refine the recommendations developed during phase 1. This phase aimed at ensuring that the proposed recommendations are both meaningful and actionable within the context of integrating circularity into project selection processes. By engaging practitioners from the field, the workshop provided critical insights into the practical relevance and feasibility of each recommendation.

5.1 Evaluation of Recommendations for action

During the workshop, the experts evaluated each recommendation based on two key dimensions: **Relevance** (ranging from 1 = very irrelevant to 5 = very relevant) and **Feasibility** (ranging from 1 = very unrealistic to 5 = very realistic). However, only six out of the seven invited experts submitted their completed evaluations, meaning that the quantitative assessment is based solely on the input from these six participants. These evaluations were averaged to provide a clear indication of how each recommendation was perceived by the group, the table containing the evaluations can be found in Appendix VII. The aggregated data is presented in Figure 19, which illustrates the distribution of recommendations on a scatter plot. Here, relevance is plotted on the x-axis, and feasibility is plotted on the y-axis. Each point on the diagram corresponds to a specific recommendation, numbered according to the list in chapter 4.2.6.

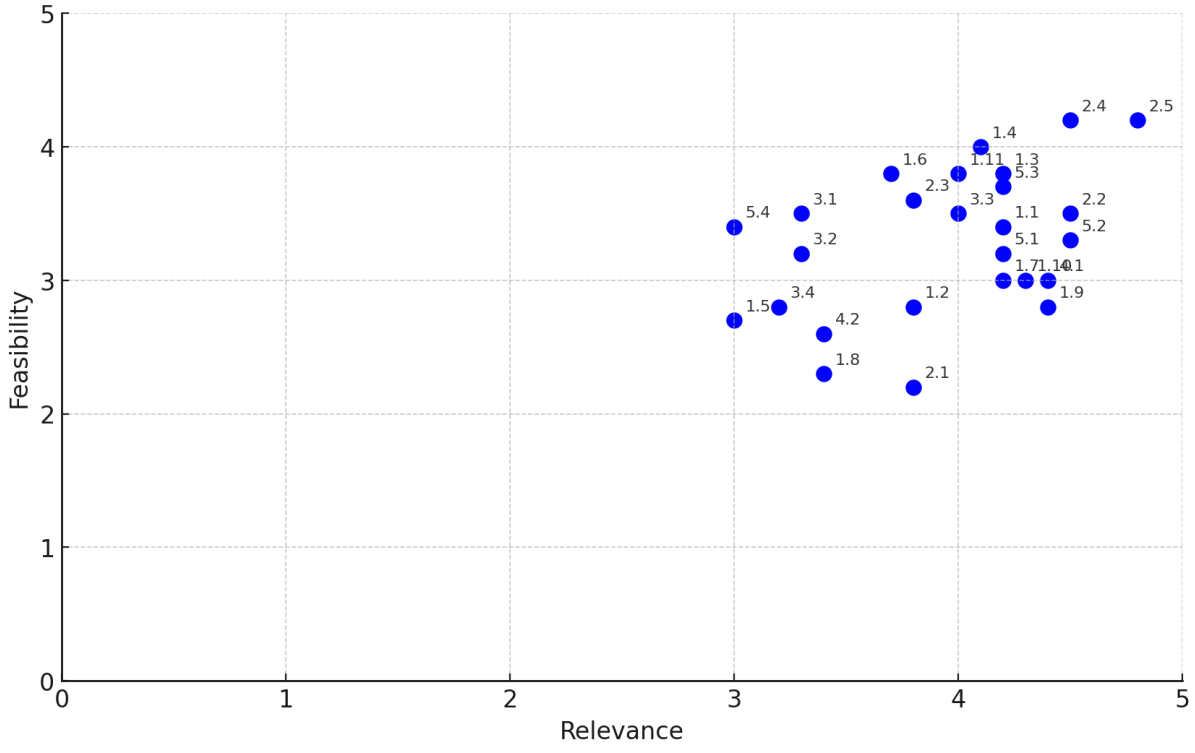

Figure 19: Scatter plot for classifying measures based on relevance and feasibility

The scatter diagram demonstrates that all recommendations fall within the upper-right quadrant, indicating that they are generally perceived as neutral to very relevant and neutral to very feasible. This positive outcome suggests that the experts find the recommendations not only meaningful but also implementable in practice. This serves as an important validation of the findings from phase 1 and underscores the potential of these recommendations to guide the integration of circularity principles effectively.

To provide a deeper level of analysis, Figure 20 focuses on the upper-right quadrant by narrowing the axes to display only the range between 2 and 5. This refinement allows for a more granular view of the distribution and categorization of recommendations.

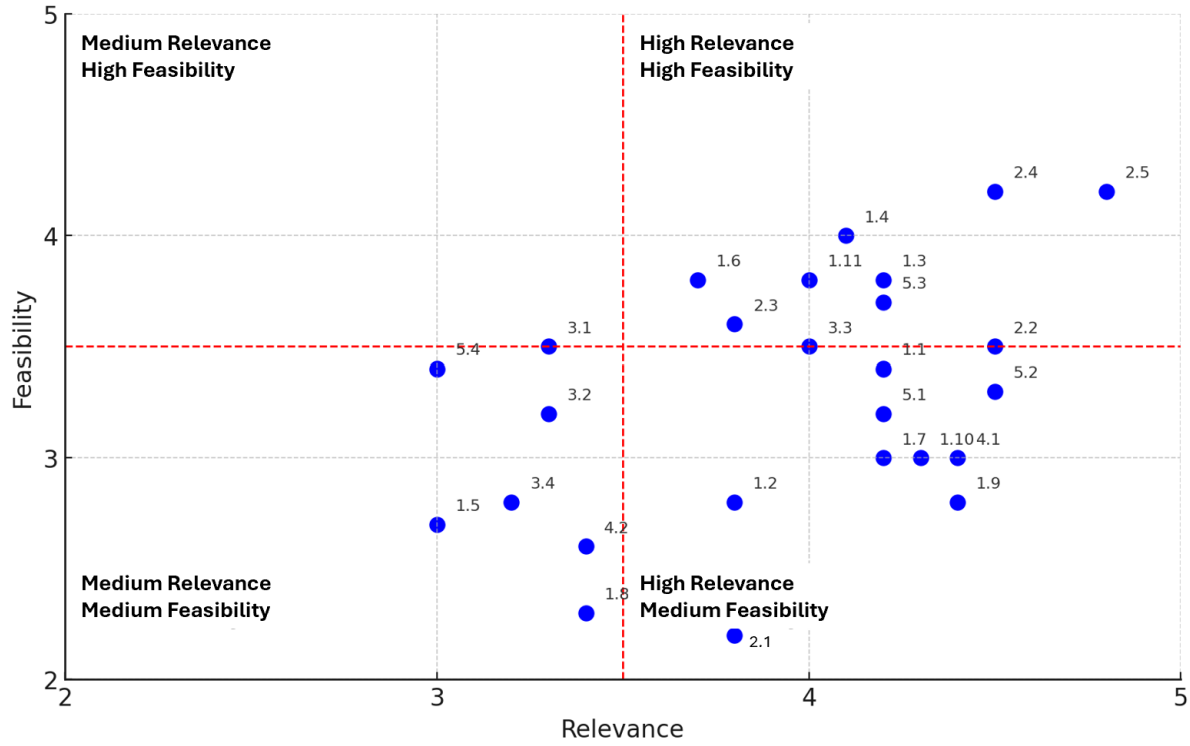

Figure 20: Scatterplot for classifying measures based on relevance and feasibility with quadrant-based categorization

Within this focused analysis, the recommendations are grouped into four quadrants, offering a structured framework for prioritization:

1. **Lower Left (Medium Relevance, Medium Feasibility):** Recommendations in this quadrant are seen as less relevant and less feasible. While they may hold potential in specific contexts, they should not be prioritized in the initial stages of circularity integration. Instead, they might be considered as long-term objectives or revisited as conditions evolve.

2. **Upper Left (Medium Relevance, High Feasibility):** Recommendations in this category are relatively easy to implement but are not considered critical at this stage. These could serve as supplementary actions that support broader efforts once the high-priority recommendations have been addressed.

3. **Lower Right (High Relevance, Medium Feasibility):** This quadrant contains recommendations that are considered highly relevant but face practical barriers to implementation. These may require additional resources, strategic planning, or innovative approaches to improve their feasibility. Despite their challenges, these recommendations should not be overlooked due to their potential value.

4. **Upper Right (High Relevance, High Feasibility):** Recommendations in this quadrant represent the easiest and most accessible opportunities for integrating circularity. They are both highly relevant and practical to implement, making them ideal starting points. These actions should be prioritized to achieve immediate impact and demonstrate the value of circularity principles.

Table 6 categorizes the recommendations into these four quadrants. By focusing on the high-relevance, high-feasibility quadrant first, project developers can achieve quick wins and build momentum for circularity integration. Simultaneously, strategies can be developed to address recommendations that are highly relevant but less feasible, ensuring that no critical opportunity is neglected.

Table 6: Tabular classification of the recommendations for action based on relevance and feasibility assessment

Upper Left (Medium Relevance, High Feasibility)	**Upper Right (High Relevance, High Feasibility)**
3.1 Corporate Culture	1.3 Do not have unrealistic expectations of higher rent income 1.4 Integrate financing requirements into the profitability calculation 1.6 Adjust vacancy rates conservatively 1.11 Assess subsidies with risks 2.2 Supplementary analysis 2.3 Early integration of circularity 2.4 Preselection criteria 2.5 Comparative analysis 3.3 Expert knowledge 5.3 Requirements of architectural firms
Lower Left (Medium Relevance, Medium Feasibility)	**Lower Right (High Relevance, Medium Feasibility)**
1.5 Include material value & building resource passport as calculative advantage 1.8 Consider long-term perspectives 3.2 Knowledge sharing 3.4 Training & education 4.2 Training & awareness raising for holistic approaches 5.4 Insurance	1.1 LCA as a basis for decisions 1.2 Evaluate reuseable materials 1.7 Analyze approval risk 1.9 Monitor political developments 1.10 Develop strategies for getting subsidies 2.1 Accurate & transparent data management 4.1 Address circularity for added components 5.1 Regulations & EU Taxonomy 5.2 Certifications

The evaluation of recommendations offers valuable insights into the perceptions of experts regarding the relevance and feasibility of various measures for integrating circularity into project selection processes. While the overall distribution of recommendations across the quadrants is logical, several placements merit closer reflection, particularly in the upper left and lower left quadrants.

Beginning with the upper left quadrant, recommendation 3.1: Corporate Culture appears to be a highly relevant measure at first glance, as corporate values can significantly influence the prioritization of circular principles within organizations. However, the experts emphasized that the actual circularity of projects is often less dependent on overarching corporate culture and more influenced by the individual motivation of project developers. This suggests that intrinsic motivation among employees plays a more decisive role than the broader cultural framework. Nevertheless, this observation opens up opportunities for companies to refine their hiring and training strategies. For instance, during recruitment processes, organizations could proactively screen candidates for their commitment to sustainability and circular principles, ensuring a stronger alignment between personal and organizational goals. This approach could help foster a workforce intrinsically motivated to champion circular practices, even in the absence of explicit

corporate directives. While corporate culture may not be the most immediate driver, it could still serve as an enabler by shaping recruitment strategies and supporting employee engagement in circularity.

The lower left quadrant contains several recommendations that, while valuable, were deemed less relevant and feasible by the experts. These include measures related to training, knowledge and understanding about circularity (recommendations 3.2, 3.4, and 4.2). The experts indicated that external measures designed to enforce education and knowledge exchange among project developers are often ineffective. Instead, intrinsic motivation once again emerges as the stronger driver of meaningful engagement with circular principles. Without a genuine personal commitment, mandatory training programs or knowledge-sharing initiatives are unlikely to yield the desired impact. This feedback highlights the need to reframe these recommendations to focus on fostering intrinsic motivation among developers rather than relying solely on external interventions. Additionally, recommendation 1.5: Include Material Value and Building Resource Passport as a Calculative Advantage, was evaluated as less relevant and feasible. Experts noted that the primary challenge here lies in the time-intensive nature of this measure. Beyond cost factors, the time required to gather and analyze data for such passports is significant, making it a less attractive option during the fast-paced project selection process. To improve the feasibility of this recommendation, future adaptations should explore ways to streamline data collection and integrate it seamlessly into existing workflows. Recommendation 1.8: Consider Long-Term Perspectives, which also falls into the lower left quadrant, presents unique challenges. While the principle of accounting for potential future taxes - such as a carbon tax - is sound, experts highlighted the inherent uncertainty and speculative nature of such assessments. Quantifying unknown future costs and incorporating them into risk assessments is a complex and often subjective process, which conflicts with the preference for data-driven, number-based decision-making in project evaluation. Developers are typically hesitant to include speculative elements in their calculations, as this can undermine the perceived reliability of their risk models. To address this challenge, future iterations of this recommendation could focus on developing scenarios or probabilistic models that allow developers to consider long-term perspectives without relying solely on speculative assumptions. These models could offer structured ways to weigh the potential impact of future risks while maintaining the robustness of quantitative evaluations.

The remaining recommendations were classified into the upper right quadrant (high relevance, high feasibility) and lower right quadrant (high relevance, medium feasibility). These represent measures that were generally well-received but also garnered feedback and suggestions for improvement. These suggestions, along with adjustments to enhance the recommendations' impact and feasibility, are discussed in detail in the following chapter.

5.2 Discussion of the recommendations for action

In addition to the quantitative evaluation, a detailed discussion of the recommendations for action was held during the workshop. The experts identified some recommendations as particularly important, made suggestions for additions and developed new recommendations for action. The key findings of this discussion are summarized below:

Discussion about theme 1: Economic feasibility and added value

On focus of the discussion was the economic feasibility and added value of circular measures. The experts agreed that financial added value is essential to implementing circular principles in projects. Nevertheless, it was noted that most circular measures are currently either financially uneconomical or neutral at best. EXP16 describes it as:

> "I believe that the circular economy is not currently a case that can be economically supported in most applications."

Instead, it requires an ideology or intrinsic motivation on the part of project developers and companies, which EXP10 mentioned as:

> "Many of the approaches require ideological conviction because they do not yet pay off economically."

In addition to financial aspects, the great expenditure of time required for certain measures was highlighted. For example, the creation of material passports was considered to be time-consuming and difficult to implement. EXP15 said:

> "The problem is often that the creation of such [circular] analyses is not only expensive but also extremely time-consuming. Especially when it comes to material collection, it often takes months."

These additional hurdles further complicate the implementation of circular approaches.

Recommendation for action 1.1: Life cycle assessment (LCA) as a basis for decision-making

The experts emphasized that life cycle assessment (LCA) is an essential tool for decision-making. However, they also pointed out the challenges of practical implementation. As EPX15 describes the process of creating an LCA:

> "Conducting life cycle assessments is a laborious process, but it is essential for long-term decision-making."

Which is why they recommend involving external specialists, planners or consultants for this task. Although this is associated with high costs, it was noted that this investment can pay off in the long term.

Recommendation for action 2.4: Pre-selection criteria

The pre-selection criteria were identified as particularly important. The experts agreed that factors such as the age of the building and location are key criteria for evaluating transformation projects. In addition, flexibility was highlighted as a crucial aspect, as EPX 14 mentioned:

> "I think it is extremely important to look at how flexible the floor plans or buildings are, for example, because that is a crucial factor for circularity."

The adaptability of building structures and floor plans was seen as a key criterion for the long-term usability and sustainability of buildings. The ability to adapt buildings to changing requirements with minimal effort was considered essential for a successful transformation.

Recommendation 3.2: Knowledge exchange

To promote knowledge sharing within teams, it was pointed out that simply mixing different generations does not automatically lead to effective knowledge sharing. Rather, the willingness to engage with the topic of circularity depends on individual motivation and curiosity, as EXP14 describes it:

> "It is up to the individual whether they are motivated to educate themselves further – regardless of age or experience."

It was recommended that further training be promoted individually and not just differentiated by age or experience groups. In addition to age and experience, other diversity factors in teams should be considered, such as gender, cultural background and professional specialization.

Recommendation for action 3.3: Expert knowledge & 3.4 Training & Education

The integration of expert knowledge was highlighted by the workshop participants as particularly valuable and forward-looking. It was emphasized that many companies do not have the internal capacity to keep employees continuously up to date with the latest developments in the field of circularity, as the dynamic and constantly changing knowledge landscape requires regular training. As EXP13 puts it:

> "Without external consultants, I currently see it as difficult to implement the necessary measures in a targeted manner."

The participants saw great potential in focusing on the commissioning of external specialist planners to effectively integrate circular principles into projects.

5.3 Revised Recommendations

The recommendations initially developed in phase 1 were refined using insights from the data analysis conducted in phase 2. Additionally, the recommendations were adjusted to incorporate valuable input from the discussions held during the expert workshops.

A prioritization of the recommendations was performed using quantitative data, distinguishing between level 1 and level 2 priorities. This prioritization is based on the quadrant analysis from Phase 2:

- Level 1 includes recommendations classified in the upper right quadrant (High Relevance & High Feasibility) and the lower right quadrant (High Relevance & Low Feasibility), which represent actions that are either highly impactful and straightforward to implement or crucial despite their complexity.
- Level 2 consists of recommendations from the upper left quadrant (Low Relevance & High Feasibility) and the lower left quadrant (Low Relevance & Low Feasibility). These are supportive actions that, while beneficial, have a lower overall impact or relevance compared to Level 1.

This structured prioritization ensures that project developers focus on level 1 recommendations as a first step, addressing the most critical and impactful measures early. Level 2 recommendations, on the other hand, should be implemented in subsequent phases, provided that sufficient capacity and resources are available.

To further enhance the utility of the recommendations, they were organized into a sequential order that aligns with the typical project selection process, creating a clear roadmap for project developers. This roadmap provides a structured guideline for integrating circular principles into real estate development, ensuring that the recommendations are applied systematically across different phases of project selection and development.

To construct this roadmap, two key figures from the literature study served as foundational references: Figure 11: Two-stage approach to project selection (Pekuri et al., 2015) and Figure 12: Sub-tasks of the project development (Friedrichsen, 2024). These figures collectively illustrate the essential stages of project selection and development, from initial filtering to detailed analysis and decision-making. Drawing from these models, the recommendations were assigned to the corresponding phases outlined in the literature. This process ensures that the roadmap is

grounded in both theoretical rigor and practical applicability, providing developers with a step-by-step framework for implementing circular principles.

Within each phase of the roadmap, a distinction is maintained between level 1 and level 2 recommendations, reflecting their prioritization based on the findings of this research. Level 1 recommendations, identified as high-relevance and high-feasibility actions, are positioned as immediate priorities to be addressed first within each phase. Level 2 recommendations, while still valuable, represent secondary actions that developers should consider once the foundational measures have been implemented or if additional resources are available. This layered approach ensures that project developers can focus on impactful, actionable steps while maintaining flexibility to integrate additional measures as project capacities allow.

By aligning the recommendations with the phases of the project selection process and differentiating between level 1 and level 2 actions, this roadmap offers a continuous and actionable guide for decision-makers. In the following sections, the recommendations are presented in the sequence of the roadmap, and their integration is visually depicted in the Figure 21. This approach not only simplifies the application of circular principles but also enhances the feasibility of their implementation by embedding them into the established workflow of project selection and development.

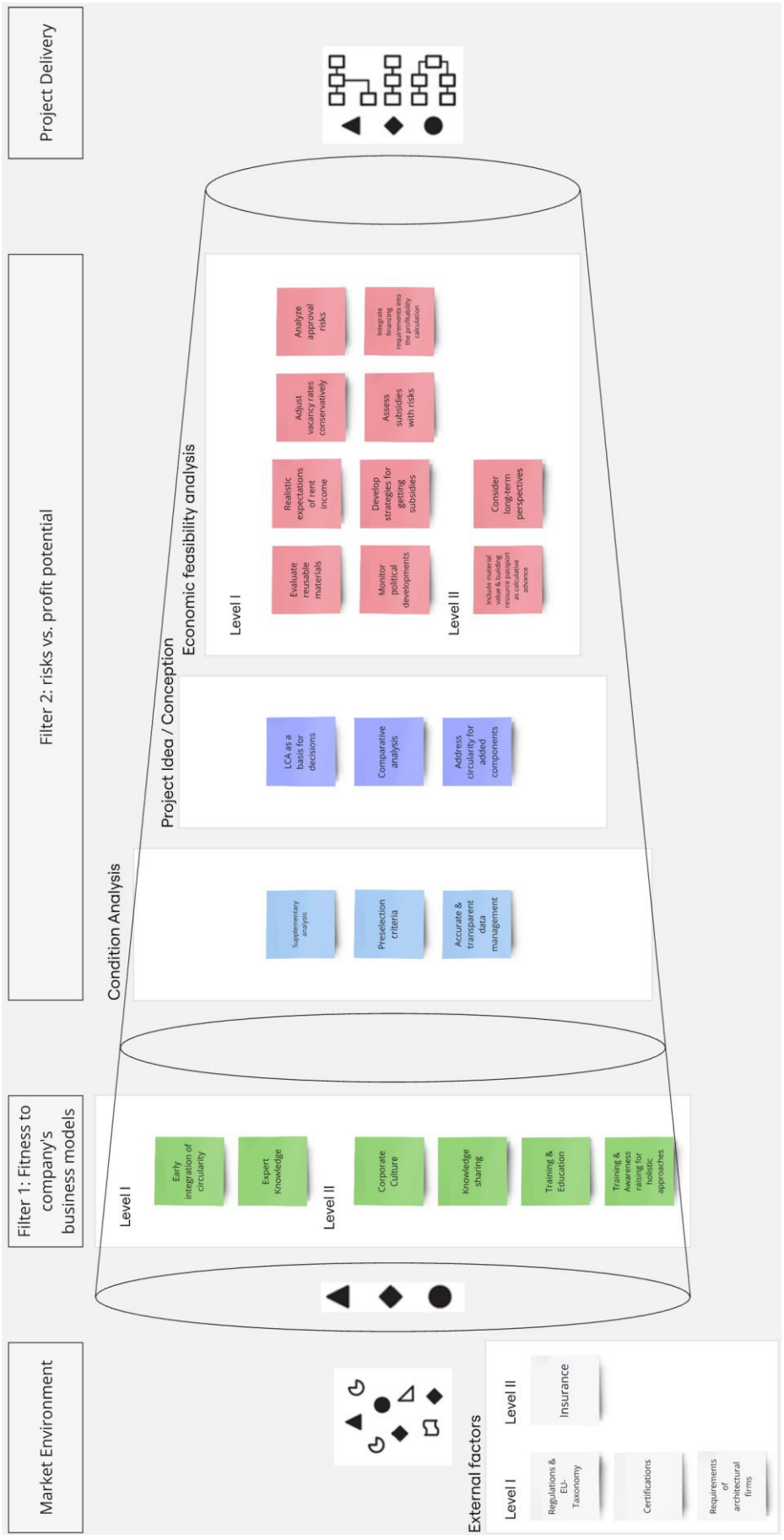

Figure 21: Roadmap for integrating circularity into project selection criteria

5.3.1 Revised Recommendations Aligned with Project Selection Process

Filter 1: Fitness to Company's Business Models

Level 1

- 2.3 Early integration of circularity: Embed circularity principles early in project planning to maximize their feasibility and impact.
- 3.3 Expert knowledge: Engage external consultants to address knowledge gaps and leverage cutting-edge insights, ensuring alignment with the latest circularity practices.

Level 2

- 3.1 Corporate culture: Establish circularity as a core value within the organization to drive project success and strengthen stakeholder alignment.
- 3.2 Knowledge sharing: Promote team diversity, including gender, cultural background, and expertise, to enhance collaboration and innovative problem-solving.
- 3.4 Training & education: Develop training programs to provide stakeholders with practical knowledge for implementing circular principles.
- 4.2 Training & awareness raising for holistic approaches: Encourage project teams to adopt comprehensive perspectives on material cycles, dismantling strategies, and resource conservation through training sessions and workshops.

Filter 2: Risks vs. Profit Potential

Following Friedrichsen's steps:

Condition Analysis

- 2.1 Accurate & transparent data management: Adopt automated systems to track material composition, dismantling potential, and reusability. This improves transparency and efficiency in data management.
- 2.2 Supplementary analysis: Use Quick Checks and ESG Due Diligence (ESG-DDs) as complementary tools for assessing circularity and sustainability.
- 2.4 Preselection criteria: Incorporate location, building age, and flexibility as key criteria in project evaluations to optimize long-term viability and reduce transformation costs.

Project Idea/Conception

- 1.1 Life cycle analysis as a basis for decisions: Standardize and integrate LCAs into project planning to evaluate long-term costs and savings. External specialists should be engaged to ensure high-quality analyses, despite their resource-intensive nature.
- 2.5 Comparative analysis: Perform systematic LCAs and scenario analyses to compare the economic and ecological impacts of circular transformation versus new construction.
- 4.1 Address circularity for added components: Prioritize circular design strategies such as modularity and "Product as a Service" models. Use material passports to assess and document material use.

Economic Feasibility Analysis

Cost

Level 1

- 1.2 Evaluate reuseable materials: Use tools like Madaster to assess the recoverability and value of materials. Practical implementation requires cost-benefit evaluations and alignment with specific project goals.
- 1.3 Do not have unrealistic expectations of higher rental income: Avoid assuming universally higher rents or sales prices for circular buildings. Instead, base financial expectations on market realities, considering location, building type, and tenant needs.

Level 2

- 1.5 Include material value & building resource passport as calculative advantages: Automate the creation of resource passports to reduce administrative burdens. While financial impact may be limited, passports enhance transparency and provide documentation advantages.

Taxes & Subsidies

Level 1

- 1.9 Monitor political developments: Stay informed on regulatory and tax changes to adapt strategies proactively and ensure compliance.
- 1.10 Develop strategies for getting subsidies: Streamline internal workflows to simplify the application process for subsidies and maximize success rates.
- 1.11 Assess subsidies with risks: Include subsidies in financial models with conservative probabilities to minimize financial uncertainty.

Level 2

- 1.8 Consider long-term perspectives: Account for potential carbon taxes or future regulatory costs in financial risk assessments. These should support, but not solely drive, decision-making.

Risk

- 1.6 Adjust vacancy rates conservatively: Set realistic vacancy expectations for circular buildings, factoring in their appeal to ESG-focused tenants and market-specific trends.
- 1.7 Analyze approval risk: Address regulatory risks proactively by establishing robust documentation processes and collaborating early with authorities.

Financing

- 1.4 Integrate financing requirements into the profitability calculation: Incorporate sustainability and circularity criteria into financial planning to unlock green financing opportunities, such as lower interest rates or increased property valuations.

Market Environment

Recommendations for external factors and drivers are aligned with the market environment on the left side of the project selection process diagram:

Level 1

- 5.1 Regulations & EU Taxonomy: Integrate compliance with EU Taxonomy requirements early in project workflows and use tools like material passports to align with regulations.
- 5.2 Certifications: Use certifications strategically to demonstrate genuine sustainability and circularity while focusing on standards that provide clear market recognition.

- 5.3 Requirements of architectural firms: Collaborate with architectural firms to define circularity goals early, ensuring alignment with stakeholder expectations.

Level 2

- 5.4 Insurance: Include insurance considerations early in project planning to mitigate risks and ensure insurability.

6. Discussion

This chapter presents the summary of key findings in 6.1 and connects the empirical findings with literature in 6.2.

6.1 Summary of Key Findings

This thesis examined how circular principles can be integrated into project selection processes in real estate development. The findings, derived from a combination of literature analysis, semi-structured interviews, and focus group discussions, provide critical insights into the practical application of circular economy concepts. These insights are organized into four key themes: circularity, drivers and barriers, project selection criteria and processes, and the integration of circular principles into selection criteria.

The study revealed a gap between theoretical understanding and practical application of circularity in the construction sector. While circular principles like adaptability, material reuse, and resource efficiency are well-documented, their implementation is often overshadowed by a focus on traditional project metrics like cost, time, and quality. A key finding was that experts prioritize energy efficiency over material-focused circular strategies, potentially influenced by regulatory frameworks such as the EU Taxonomy. This emphasis on energy efficiency mirrors industry-wide biases but also highlights a need for balanced approaches that give equal importance to material cycles. Furthermore, experts frequently cited a lack of understanding of circularity's long-term benefits as a barrier to its broader adoption.

The study confirmed many drivers and barriers identified in the literature while also uncovering new dimensions. Drivers such as regulatory frameworks (e.g., the EU Taxonomy), economic incentives, and technological advancements (e.g., material passports) are crucial for promoting circularity. Tools like material passports, often highlighted in the literature as valuable during the manufacturing phase, were found to be critical during the project selection phase as well, enabling better decision-making and long-term value creation. Barriers such as high upfront costs, regulatory inflexibility, and technical challenges were consistent with existing research. Experts also highlighted practical barriers, such as the difficulty of integrating circular strategies into existing workflows and the lack of standardized metrics to evaluate circular projects. This aligns with prior findings that underscore the complexity of implementing circularity in the construction industry.

The study underscored the importance of early-stage project evaluations and the integration of circularity into the front-end management phase. Experts emphasized that adaptability - such as the flexibility of building structures and layouts - should be a central criterion during project evaluations. However, the empirical findings revealed that not all theoretically identified adaptability factors are assessable during the project selection phase. Stakeholder dynamics emerged as another critical consideration, with the study highlighting the diverse requirements of banks, investors, regulators, and tenants as central to project feasibility. Effective stakeholder engagement, as discussed in the literature, is essential for aligning project goals with circularity principles.

A major insight from the findings was the necessity of integrating circularity into existing selection frameworks. The literature emphasizes detailed front-end management and early integration of sustainability principles as critical to project success. This was strongly validated by empirical data, where experts stressed the importance of embedding circularity from the initial project evaluation phase. Tools like life cycle analysis (LCA) and systematic data management systems

emerged as key enablers for this integration. Additionally, experts highlighted the role of corporate culture in driving long-term adoption of circularity principles. Without embedding circularity into organizational values, its application risks being superficial and project-specific rather than systemic and enduring.

By combining these findings, the study provides a robust framework for addressing the challenges and opportunities of integrating circularity into real estate project selection processes. The research underscores the importance of early-stage decision-making, balanced evaluation criteria, and collaborative stakeholder management in achieving successful circular transformations.

6.2 Connecting Empirical Findings with Literature

The findings from this study align closely with existing literature while providing additional insights into the practical application of circularity in real estate development. This section connects empirical results with theoretical foundations, addressing circularity and related missconceptions, drivers and barriers, project selection criteria, and the integration of circularity into selection processes.

Circularity and fragmented Understanding About Circularity

The study highlights a recurring misconception within the industry: circularity is often perceived as secondary to traditional priorities such as cost, time, and quality, known as the Iron Triangle. This aligns with research by Pfnür and Wagner (2020), who argue that the misalignment between project selection methods and business objectives limits the integration of circular practices. Both the interviews and focus group discussions confirmed that developers prioritize these metrics due to their direct impact on short-term project feasibility. This deprioritization of circularity is further reinforced by the interchangeable use of the terms circularity and sustainability, which became evident during the interviews conducted for this study. Developers often equated circularity with broader sustainability efforts, focusing predominantly on energy efficiency. This focus is driven by frameworks like the EU Taxonomy, which emphasize energy's role in mitigating climate change. While this aligns with established regulatory and market incentives, it obscures the distinct contributions of circularity, such as material cycles, adaptability, and resource efficiency. The experts' discussions highlighted that this conflation often stems from a lack of standardized metrics or a clear industry-wide definition of circularity, making it easier to subsume it under the broader and more established concept of sustainability. Although the literature acknowledges the importance of material cycles Hamida et al. (2023), this aspect remains underexplored in practice. By treating circularity as merely a subset of sustainability, the industry continues to overlook its transformative potential, particularly in addressing resource management and building adaptability. This highlights the need for clearer differentiation and targeted efforts to integrate circular principles into project development processes.

Drivers and Barriers

The empirical findings validated several drivers and barriers identified in the literature. Drivers such as material passports and digital tools were frequently mentioned. Material passports, typically discussed in the literature during the manufacturing phase (Hebel & Heisel, 2022), were highlighted by experts as vital during the project selection phase. Their early adoption allows better documentation of material value and reuse potential, providing a basis for informed decision-making. Additionally, the importance of transparency and comparability was

emphasized, with experts advocating for a unified digital platform to standardize circularity assessments across projects, echoing suggestions by Kooter et al. (2021).

Barriers, including high upfront costs, lack of standard metrics, and regulatory rigidity, were prominent in both the literature and empirical findings (Munaro & Tavares, 2023). For instance, the absence of streamlined processes for integrating circular strategies into existing workflows was noted as a significant hurdle. Furthermore, experts corroborated the literature's claims that inadequate stakeholder alignment hinders circular adoption, as differing priorities among investors, tenants, and regulatory bodies complicate implementation (Williams & Dair, 2007).

Project Selection Criteria and Processes

The importance of adaptability emerged as a central theme in this study, reinforcing findings in the literature (Eisele et al., 2020). While adaptability encompasses multiple factors, experts prioritized structural flexibility and layout adaptability as critical for assessing a project's feasibility. However, the empirical findings also revealed limitations in applying all theoretical adaptability criteria during the project evaluation phase, highlighting a disconnect between theoretical frameworks and practical applicability.

Stakeholder analysis, emphasized in the literature as a key component of project selection (Williams & Dair, 2007), was validated by the study. Experts frequently discussed the demands of banks, investors, regulators, and tenants, which significantly influence project evaluation. Aligning these diverse stakeholder priorities with circular principles remains a complex yet essential task.

Integration of Circularity into Selection Criteria

The study strongly supported the literature's emphasis on early integration of circular principles through detailed front-end management (Olsson & Samset, 2006). Experts consistently emphasized the importance of embedding circularity into the initial stages of project evaluation to maximize its impact. Tools like life cycle analysis (LCA) were highlighted as enablers for this integration, aligning with frameworks proposed by the Ellen MacArthur Foundation (2015). Additionally, the importance of circularity indicators, as discussed by Cottafava and Ritzen (2021), was evident in experts' suggestions to develop visual tools, such as pie charts, for assessing and comparing circularity metrics. These tools facilitate standardized evaluations and provide valuable data for future projects.

Corporate culture emerged as a crucial determinant of circularity adoption, consistent with findings by Pfnür and Wagner (2020). The empirical study revealed that many organizations fail to integrate circularity into their broader strategies, instead applying it on a project-specific basis. This highlights the need for systemic changes within organizations to foster long-term commitment to circular principles. The recommendation to prioritize corporate culture underscores the necessity of aligning organizational values with sustainability goals.

The two-filter model by Pekuri et al. (2015) serves as the foundation for the roadmap, providing a systematic structure for project selection processes. The first filter focuses on assessing the fitness of a potential project with the company's business model, evaluating whether the project aligns strategically and operationally with the organization's goals and priorities. However, as highlighted by Pfnür and Wagner (2020), many business models in the real estate sector are not yet sufficiently designed to integrate circularity effectively. To remain competitive in the long term, business models must evolve to incorporate principles such as material cycles, resource efficiency, and sustainable value creation. Without these adjustments, companies risk missing opportunities offered by circular projects and failing to meet regulatory and societal demands.

Therefore, the first filter should not only evaluate current "fitness" but also encourage companies to adapt their business models to fully embrace and support circularity.

7. Conclusion

This master's thesis investigates how circular principles can be effectively integrated into project selection processes, focusing on the transformation of existing buildings. It bridges the gap between circular economy theory and practical application, offering insights to advance circularity in real estate development.

The first sub-question: What are the circular principles that can be applied in real estate development, and what are their drivers and barriers?

The circular economy in real estate development aims to replace the linear "take, make, dispose" model with principles that prioritize reducing resource consumption, reusing materials, and recycling components to minimize environmental impact (Ellen MacArthur Foundation, 2015). Additional approaches, such as regenerating resources, optimizing efficiency, and creating closed material loops, enhance these core principles (Hamida et al., 2023). These concepts are applied across the building lifecycle - from design and manufacture to operation and end-of-life - ensuring that materials are used efficiently, and waste is minimized (Hebel & Heisel, 2022). Key drivers for adopting circular principles include political frameworks like the EU Taxonomy, which incentivizes circular practices through sustainable financing (European Commission, 2020); economic benefits, such as reduced material costs and marketplaces for circular materials (Pfnür & Wagner, 2020); and technical tools like material passports and circularity indicators, which enhance transparency and reuse potential (Kooter et al., 2021). Social and cultural drivers, including urban regeneration and cultural preservation, further promote acceptance and implementation (Williams & Dair, 2007). However, barriers persist. Technical challenges, such as the complexity of reusing building components, and economic hurdles, like high upfront costs and limited subsidies, hinder widespread adoption (Munaro & Tavares, 2023). Regulatory rigidity, insufficient awareness, and a lack of collaborative management frameworks exacerbate these challenges, limiting the scalability of circular practices in the sector (Cottafava & Ritzen, 2021). Transforming existing buildings through adaptive reuse, revitalization, and structural transformation demonstrates the potential of circular principles to reduce resource use and extend building lifecycles (Eisele et al., 2020). While these principles offer significant opportunities, addressing technical, economic, and regulatory barriers is essential for driving the transition toward sustainable real estate development (Olsson & Samset, 2006).

The second sub-question: What are the selection criteria for projects for real estate development?

The selection of real estate development projects is a complex process that balances profitability with strategic goals. Front-end management plays a critical role, as early decisions shape project feasibility, lifecycle costs, and long-term success. Effective planning at this stage significantly increases the likelihood of successful outcomes (Olsson & Samset, 2006). Key criteria for evaluation include environmental factors, such as site condition and adaptability, financial assessments using tools like life cycle costing (Mooya, 2016), and institutional alignment with organizational goals (Pekuri et al., 2015). Risk considerations, such as structural uncertainties and hazardous materials, are particularly relevant for transformation projects (Glückert, 2023). Technical aspects like material reuse, energy efficiency, and stakeholder collaboration further ensure alignment with circularity and sustainability objectives. The process integrates these criteria into a structured framework, as described by Friedrichsen (2024), which includes status analysis, project conception, and profitability evaluation. For circular transformations, these steps address unique challenges, including material reuse and adaptability. While traditional

metrics like the Iron Triangle remain important, integrating sustainability into project selection ensures decisions that drive both profitability and environmental responsibility.

The third sub-question: How can a framework for project developers integrate circular principle s in the process of selecting real estate development projects?

Integrating circular principles into project selection for real estate development requires a structured framework that addresses industry challenges and incorporates practical insights. Embedding circularity in front-end management ensures that early decisions prioritize adaptability, material reuse, and resource efficiency. Tools such as life cycle analysis (LCA) enable early evaluation of environmental and economic impacts, guiding sustainable decision-making. Key criteria, including structural adaptability and material reuse, are vital for transforming existing buildings. Material passports and Building Information Modelling (BIM) support transparency and efficient resource use. Circularity indicators provide a standardized method for evaluating projects, ensuring consistent decision-making. Collaboration, particularly involving external experts, and effective governance structures are essential to bridge knowledge gaps and align stakeholders. Balancing short-term cost concerns with long-term benefits is critical. Life cycle costing helps justify initial investments by highlighting sustainability gains, while aligning with frameworks like the EU Taxonomy can unlock financial incentives. By integrating circular principles into the earliest stages of project selection, supported by advanced tools and stakeholder collaboration, developers can align sustainability with strategic goals, fostering a resource-efficient future in real estate development.

Main research question: How can circular principles be integrated into project selection criteria in real estate development?

The main research was addressed by aligning findings from literature and empirical analysis. A structured framework was developed, which enables the systematic integration of circular principles into key decision-making phases, such as condition analysis, project conception, and economic feasibility assessments. High-priority measures, such as early integration of circularity and leveraging expert knowledge, offer immediate opportunities for impactful implementation. Challenges, including the resource-intensive nature of tools like life cycle analysis and material passports, underscore the need for financial incentives and regulatory support. The emphasis on economic feasibility highlights the importance of aligning circular principles with developers' financial goals. This research provides a practical roadmap for integrating circularity into project selection processes, offering actionable steps for the real estate sector to transition toward circularity while balancing economic, social, and environmental objectives.

The chapter continues with addressing the practical implications of this study in 7.1 and the scientific implications in 7.2. In 7.3 the research limitations are presented and 7.4 includes several recommendations for future research.

7.1 Practical implications

The findings of this research have significant implications for practice, offering actionable insights for project developers, policymakers, and the construction industry. By addressing the gaps in clear criteria and standardized methods for evaluating circular transformations, this thesis provides concrete decision-making tools that can guide the selection and realization of circular projects.

For project developers, the proposed framework integrates circular principles into early-stage project evaluation. Tools like life cycle analysis (LCA) and circularity pie charts enable a

systematic assessment of circular potential, helping developers prioritize projects that are both resource-efficient and economically viable. These tools offer the potential to optimize decision-making, reduce project risks, and align with long-term sustainability goals. The explicit focus on adaptability, for instance, ensures that selected projects can accommodate future needs, while the integration of transparent data management fosters comparability and standardization across projects. This approach equips developers with practical, scalable methods to navigate the complexities of circular transformations.

For policymakers, the study highlights their crucial role in addressing the barriers to feasibility, particularly as economic viability emerged as the most important factor for project developers. The findings indicate that without clear financial incentives or regulatory support, circular projects often struggle to compete with traditional, linear alternatives due to higher upfront costs and perceived risks. Policymakers can enhance feasibility by implementing targeted subsidy programs and tax incentives that directly address these financial concerns. Furthermore, adapting the building permit process to prioritize circular projects could streamline approvals and reduce administrative burdens, making these projects more attractive to developers. By creating a supportive regulatory and financial environment, policymakers can not only encourage the adoption of circular principles but also lower the economic barriers that currently limit their feasibility. Such measures would ensure that project developers see clear economic advantages in pursuing circular transformations, driving broader adoption of sustainable practices and aligning industry priorities with national and international climate goals.

At the industry level, this research underscores the growing importance of external expertise in the successful implementation of circularity. The findings reveal that project developers often lack the internal capacity or knowledge to manage the complexities of circular projects, making the inclusion of external experts a critical factor for success. As demand for specialized consulting services related to circularity increases, companies can seize the opportunity to position themselves as leaders in this emerging field. Firms that proactively build capacity in areas such as life cycle assessments, material passport creation, and adaptability evaluations will be well-placed to meet this rising demand. By investing in training and expertise, these companies can establish themselves as key enablers of the construction sector's transition toward circularity, while fostering innovation and collaboration across the industry.

7.2 Scientific Implications

This research contributes to the growing academic discourse on circular economy in real estate development by addressing a key gap: the integration of circularity into project selection processes. While existing literature explores circular construction methods and sustainability in real estate, few studies systematically link these concepts to structured project evaluation frameworks. This thesis advances the field by providing an approach to embedding circular principles into decision-making, aligning economic feasibility with sustainability objectives.

One significant scientific contribution is the synthesis of circular economy theories with established project selection methodologies. The study builds upon frameworks such as front-end management (Olsson & Samset, 2006) and filtering-based selection models (Pekuri et al., 2015), demonstrating how these can incorporate circularity criteria. By connecting sustainability-driven selection factors - such as adaptability, material reuse potential, and long-term life cycle costs - to established project evaluation models, this research offers a structured approach to integrating circular economy principles into early decision-making.

Furthermore, the findings provide empirical analysis on the challenges and enablers of circular project selection. While previous studies emphasize barriers like regulatory rigidity, cost concerns, and technical complexity (Munaro & Tavares, 2023; Charef et al., 2021), this thesis offers a nuanced perspective by detailing how real estate professionals perceive and navigate these challenges in practice. The combination of qualitative interviews and a focus group validation process enhances the reliability of these insights, providing a robust foundation for further research.

Additionally, this study underscores the role of corporate culture and interdisciplinary collaboration in facilitating circularity. The findings highlight that beyond technical and financial considerations, successful circular transformations require shifts in organizational mindset, stakeholder alignment, and knowledge-sharing mechanisms. This aligns with emerging discussions on the socio-economic dimensions of circularity transitions in the built environment (Eisele et al., 2020).

7.3 Research Limitation

This research provides valuable insights into integrating circular principles into the project selection processes of real estate development, but several limitations must be acknowledged. These limitations pertain to the study's scope, methodology, and contextual constraints, which may affect the generalizability and applicability of the findings.

One significant limitation is the geographic scope of the study. The research primarily focuses on the German context, where regulatory frameworks such as the EU Taxonomy and industry-specific drivers heavily influence the adoption of circular principles. While this provides a comprehensive understanding of circularity in Germany, the findings may not fully apply to regions with different regulatory environments, economic conditions, or cultural attitudes toward circularity.

The sample size and composition also pose limitations. The study relied on semi-structured interviews and a focus group discussion with a relatively small group of experts. While these participants provided valuable insights, their perspectives may not represent the broader range of stakeholders involved in real estate development, such as tenants, smaller developers, or policymakers. Expanding the sample size and diversity could provide a more nuanced understanding.

Another limitation relates to the focus on early-stage project selection. While this study offers a robust framework for integrating circular principles at the selection phase, it does not address the implementation and monitoring of circularity throughout the entire project lifecycle. Factors such as material sourcing, construction practices, and operational management, which also play a critical role in achieving circularity, were beyond the scope of this research.

The rapidly evolving nature of the field further limits the long-term applicability of some findings. As circular economy practices, tools, and technologies continue to advance, recommendations based on current conditions may require adaptation. For instance, tools like material passports and circularity indicators are still in development, and their widespread adoption could change the feasibility and prioritization of certain criteria.

Lastly, the research relied heavily on qualitative methods, which are subject to interpretative bias. Although every effort was made to ensure stringent data collection and analysis, the findings are inherently influenced by the experiences and opinions of the participants and the researcher.

7.4 Recommendations for future research

This research lays a foundation for integrating circular principles into project selection processes for real estate development. However, several areas warrant further exploration to build on and refine the findings of this study. The following recommendations highlight key directions for future research.

One promising avenue is the use of case studies to complement the findings from this research. By analyzing completed projects that have implemented circular principles, researchers can gain insights into the real-world outcomes of specific measures. Case studies would allow for a comparative evaluation of the proposed framework and recommendations, providing practical evidence of their effectiveness or identifying areas for improvement. For instance, examining projects that utilized tools like material passports or life cycle analyses could reveal the tangible benefits and challenges of these measures in practice.

Another area for further investigation is the time investment required for circular measures. While this research primarily focused on financial feasibility as a key factor influencing project selection, time constraints also play a critical role in the implementation of circular practices. Future studies could evaluate the time demands of various circular measures, such as conducting material assessments or adapting existing structures for reuse. Developing a framework to classify measures based on their time requirements could help project developers prioritize actions that balance feasibility with impact.

Expanding the scope of research to include different geographic contexts is another important consideration. This study primarily focused on the German context, where regulatory frameworks like the EU Taxonomy influence circularity adoption. Future research could explore how circular principles are applied in regions with different regulatory environments, economic conditions, and cultural attitudes toward circularity. This would enhance the global applicability of the findings and provide insights into context-specific barriers and drivers.

Additionally, there is potential to explore the integration of circularity into later project phases, such as construction and operation. While this research focused on the early stages of project selection, further studies could investigate how circular principles can be monitored and implemented throughout a building's lifecycle. This could include examining the operational benefits of circularity or the effectiveness of dismantling processes for reusing materials at a project's end of life.

Lastly, future research could explore quantitative validation of circularity metrics. Developing standardized tools to measure and compare the circular performance of projects would enhance transparency and decision-making. Large-scale quantitative studies could validate the effectiveness of measures like adaptability, material reuse, or stakeholder collaboration in achieving sustainability goals, providing robust data to support project selection processes.

8. References

Aigwi, I. E., Duberia, A., & Nwadike, A. N. (2023). Adaptive reuse of existing buildings as a sustainable tool for climate change mitigation within the built environment. *Sustainable Energy Technologies and Assessments*, *56*, 102945. https://doi.org/10.1016/j.seta.2022.102945

Akhimien, N. G., Latif, E., & Hou, S. S. (2021). Application of circular economy principles in buildings: A systematic review. *Journal of Building Engineering*, *38*, 102041. https://doi.org/10.1016/j.jobe.2020.102041

Benachio, G. L. F., Freitas, M. d. C. D., & Tavares, S. F [Sergio Fernando] (2020). Circular economy in the construction industry: A systematic literature review. *Journal of Cleaner Production*, *260*, 121046. https://doi.org/10.1016/j.jclepro.2020.121046

Bize, E. (2024). *Accelerating the circular economy in Europe: State and outlook 2024*. *EEA report: 2023, 13*. Publications Office of the European Union. https://op.europa.eu/o/opportal-service/download-handler?identifier=5ab42459-e688-11ee-8b2b-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part= https://doi.org/10.2800/055236

Bragadin, M. A., Guardigli, L., Calistri, M., & Ferrante, A. (2023). Demolishing or Renovating? Life Cycle Analysis in the Design Process for Building Renovation: The ProGETonE Case. *Sustainability*, *15*(11), 8614. https://doi.org/10.3390/su15118614

bulwiengesa. (2024, October 21). *Die Erfindung der A-Stadt | bulwiengesa*. https://bulwiengesa.de/de/vierzig/geschichten/die-erfindung-der-stadt

Centraal Bureau voor de Statistiek (2023, November 6). 9,6 duizend woningen door transformaties in 2022. *Centraal Bureau Voor De Statistiek*. https://www.cbs.nl/nl-nl/nieuws/2023/45/9-6-duizend-woningen-door-transformaties-in-2022

Charef, R., Ganjian, E., & Emmitt, S. (2021). Socio-economic and environmental barriers for a holistic asset lifecycle approach to achieve circular economy: A pattern-matching method. *Technological Forecasting and Social Change*, *170*, 120798. https://doi.org/10.1016/j.techfore.2021.120798

European Parliament. (2024, June 18). *Energy efficiency of buildings: MEPs adopt plans to decarbonise the sector: Press Releases* [Press release]. https://www.europarl.europa.eu/news/de/press-room/20240308IPR19003/gebaudeenergieeffizienz-parlament-nimmt-plane-fur-co2-armere-gebaude-an

Colliers, Garbe, & PwC (2024). Obsoleszenzrisiken von Büroimmobilien – Wohnen und Life Science als Ausweg?

Cottafava, D., & Ritzen, M. (2021). Circularity indicator for residential buildings: Addressing the gap between embodied impacts and design aspects. *Resources, Conservation and Recycling*, *164*, 105120. https://doi.org/10.1016/j.resconrec.2020.105120

Directorate-General for Financial Stability, Financial Services and Capital Markets Union. (2020, August 5). *Renewed sustainable finance strategy and implementation of the action plan on financing sustainable growth*. European Commission. https://finance.ec.europa.eu/publications/renewed-sustainable-finance-strategy-and-implementation-action-plan-financing-sustainable-growth_en

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. (2024, August 9). *SME definition*. https://single-market-economy.ec.europa.eu/smes/sme-fundamentals/sme-definition_en

Dişli, G., & Ankaralıgil, B. (2023). Circular economy in the heritage conservation sector: An analysis of circularity degree in existing buildings. *Sustainable Energy Technologies and Assessments*, *56*, 103126. https://doi.org/10.1016/j.seta.2023.103126

Ebbesen, J. B., & Hope, A. J. (2013). Re-imagining the Iron Triangle: Embedding Sustainability into Project Constraints. *PM World Journal*.

Edkins, A., Geraldi, J., Morris, P., & Smith, A. (2013). Exploring the front-end of project management. *Engineering Project Organization Journal*, *3*(2), 71–85. https://doi.org/10.1080/21573727.2013.775942

Eisele, J., Harzdorf, A., Hüttig, L., Otto, J., Stroetmann, R., Trautmann, B., & Weller, C. (2020). *Multifunktionale Büro- und Geschäftshäuser: Planung – Konstruktion – Ökologie – Ökonomie*. Springer Vieweg.

Ellen MacArthur Foundation (2015). Growth within: A circular economy vision for a competitive Europe. https://www.ellenmacarthurfoundation.org/growth-within-a-circular-economy-vision-for-a-competitive-europe

Friedrichsen, S. (2024). *Nachhaltige Immobilien-Projektentwicklung: Schnelleinstieg für Architekten und Bauingenieure* (1st ed. 2024). *essentials*. Springer Fachmedien Wiesbaden; Imprint Springer Vieweg. https://doi.org/10.1007/978-3-658-45081-6

Gebetsroither, M., Honic, M., & Kovacic, I. (2024). *Paradigmenwechsel in Bau- und Immobilienwirtschaft: Mit Kreislaufwirtschaft und Digitalisierung die Zukunft gestalten*. *Open Access*. Springer Spektrum. https://link.springer.com/978-3-662-68275-3

Glückert, B. (2023). Ressourceneinsparung im Bauwesen: Die Rolle der Revitalisierung aus Sicht der Planer. *Beton- Und Stahlbetonbau*, *118*(5), 361–371. https://doi.org/10.1002/best.202300027

Hamida, M. B., Jylhä, T., Remøy, H., & Gruis, V. (2023). Circular building adaptability and its determinants – A literature review. *International Journal of Building Pathology and Adaptation*, *41*(6), 47–69. https://doi.org/10.1108/IJBPA-11-2021-0150

Haynes, B., & Nunnington, N. (2010). *Corporate Real Estate Asset Management: Strategy and Implementation* (1. Aufl.). Elsevier professional. http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10404668

Hebel, D. E., & Heisel, F. (2022). *Besser - Weniger - Anders Bauen: Kreislaufgerechtes Bauen und Kreislaufwirtschaft: Grundlagen - Fallbeispiele - Strategien*. Birkhäuser. https://ebookcentral.proquest.com/lib/kxp/detail.action?docID=7127783

Hoogendijk, S., & Bolt, G. (2020, March 31). The built environment: The effects of office conversions in the Netherlands. *Open Access Government*. https://www.openaccessgovernment.org/office-conversions/84577/

Hwang, S. (2008). Utilizing Qualitative Data Analysis Software. *Social Science Computer Review*, *26*(4), 519–527. https://doi.org/10.1177/0894439307312485

Kooter, E., van Uden, M., van Marrewijk, A., Wamelink, H., van Bueren, E., & Heurkens, E. (2021). Sustainability Transition through Dynamics of Circular Construction Projects. *Sustainability*, *13*(21), 12101. https://doi.org/10.3390/su132112101

Leal Filho, W., Azul, A. M., Doni, F., & Lange Salvia, A. (Eds.). (2023). *Handbook of sustainability science in the future: Policies, technologies and education by 2050*. Springer. https://doi.org/10.1007/978-3-031-04560-8

Mayring, P. (2014). Qualitative Content Analysis: Qualitative content analysis: theoretical foundation, basic procedures and software solution. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173

Meijer, R., & Buitelaar, E. (2023). What drives developers? Understanding vertical (dis)integration strategies in the land development process. *Land Use Policy*, *131*, 106718. https://doi.org/10.1016/j.landusepol.2023.106718

Misnan, M. S., Ismail, M. Z., & Yan, T. J. (2024). Construction Project Management Issues and Development in Current for Future Construction Project: Challenges and Prospects in Sustainable Project Management. *International Journal of Research and Innovation in Social Science*, *VIII*(II), 1997–2011. https://doi.org/10.47772/IJRISS.2024.802141

Mooya, M. M. (2016). *Real Estate Valuation Theory: A Critical Appraisal* (1st ed. 2016). Springer Berlin Heidelberg; Imprint: Springer.

Munaro, M. R., & Tavares, S. F [Sérgio Fernando] (2023). A review on barriers, drivers, and stakeholders towards the circular economy: The construction sector perspective. *Cleaner and Responsible Consumption*, *8*, 100107. https://doi.org/10.1016/j.clrc.2023.100107

Munaro, M. R., Tavares, S. F [Sérgio Fernando], & Bragança, L. (2020). Towards circular and more sustainable buildings: A systematic literature review on the circular economy in the built environment. *Journal of Cleaner Production*, *260*, 121134. https://doi.org/10.1016/j.jclepro.2020.121134

Musarat, M. A., Maqsoom, A., Naeem, M. H., Ullah, F., Salman, A., Alaloul, W. S., & Zahoor, H. (2024). Evaluating the correlation between project selection criteria and organizational performance within the construction industry. *Ain Shams Engineering Journal*, *15*(7), 102794. https://doi.org/10.1016/j.asej.2024.102794

Olsson, N. O. E., & Samset, K. (2006). *Front-end project management, flexibility - project success*. https://www.pmi.org/learning/library/front-end-project-management-success-7998#:~:text=The%20main%20aim%20of%20front,end%20phase%20than%20during%20implementation.

Peiris, S., Lai, J. H., Kumaraswamy, M. M., & Hou, H. (2023). Smart retrofitting for existing buildings: State of the art and future research directions. *Journal of Building Engineering*, *76*, 107354. https://doi.org/10.1016/j.jobe.2023.107354

Pekuri, A., Pekuri, L., & Haapasalo, H. (2015). Business models and project selection in construction companies. *Construction Innovation*, *15*(2), 180–197. https://doi.org/10.1108/CI-12-2013-0055

Pfnür, A., & Wagner, B. (2020). Transformation of the real estate and construction industry: empirical findings from Germany. *Journal of Business Economics*, *90*(7), 975–1019. https://doi.org/10.1007/s11573-020-00972-4

Pollack, J., Helm, J., & Adler, D. (2018). What is the Iron Triangle, and how has it changed? *International Journal of Managing Projects in Business*, *11*(2), 527–547. https://doi.org/10.1108/IJMPB-09-2017-0107

Rokio, M., Ahola, T., Alkki, L., & Ståhle, M. (2024). Projects as drivers of sustainability: How the adoption of the reuse principle affects the front-end of a construction project. *International Journal of Project Management*, *42*(7), 102647. https://doi.org/10.1016/j.ijproman.2024.102647

Rymarzak, M., & Siemińska, E. (2012). Factors affecting the location of real estate. *Journal of Corporate Real Estate*, *14*(4), 214–225. https://doi.org/10.1108/JCRE-11-2012-0027

Sah, V., Gallimore, P., & Sherwood Clements, J. (2010). Experience and real estate investment decision-making: a process-tracing investigation. *Journal of Property Research*, *27*(3), 207–219. https://doi.org/10.1080/09599916.2010.518402

Senaratne, S., Rodrigo, N., Almeida, L. M., Perera, S., & Jin, X. (2023). Systematic review on stakeholder collaboration for a circular built environment: Current research trends, gaps

and future directions. *Resources, Conservation & Recycling Advances*, *19*, 200169. https://doi.org/10.1016/j.rcradv.2023.200169

Statista. (2024). *Wichtigste Länder Europas nach Höhe der Bauinvestitionen 2023 | Statista*. https://de.statista.com/statistik/daten/studie/165790/umfrage/bauinvestitionen-in-ausgewaehlten-laendern-der-eu-27/

Viola, S., & Diano, D. (2019). Repurposing the Built Environment: Emerging Challenges and Key Entry Points for Future Research. *Sustainability*, *11*(17), 4669. https://doi.org/10.3390/su11174669

Waldburg, H., Janssen, O., Koschny, R.-P., & Embacher, F. (2022). Marktstudie: Transformationsimmobilien. https://realestate.union-investment.com/media-center/studien-und-umfragen/transformationsstudie-2022

Williams, K., & Dair, C. (2007). What is stopping sustainable building in England? Barriers experienced by stakeholders in delivering sustainable developments. *Sustainable Development*, *15*(3), 135–147. https://doi.org/10.1002/sd.308

Young, J., Phipps, A., Swinnerton, E., Almond, N., & Dhillon, S. (2023). Europe Obsolescence Equals Opportunity: The next evolution of office and how repositioning and repurposing will shape the future of european real estate. https://cwrealkapital.no/wp-content/uploads/sites/2/2017/07/Obsolescence-Equals-Opportunity_The-Next-Evolution-of-Europe-Office-Market.pdf

Zhang, X., Shen, L., Wu, Y., & Fan, L. C. N. (2009). COMPETITIVENESS ASSESSMENT FOR REAL ESTATE ENTERPRISES IN CHINA: A MODEL-PROCEDURE. *International Journal of Strategic Property Management*, *13*(3), 229–245. https://doi.org/10.3846/1648-715X.2009.13.229-245

Zimmermann, R. K., Barjot, Z., Rasmussen, F. N., Malmqvist, T., Kuittinen, M., & Birgisdottir, H. (2023). GHG emissions from building renovation versus new-build: incentives from assessment methods. *Buildings and Cities*, *4*(1). https://doi.org/10.5334/bc.325

9. Appendix

9.1 Appendix I

Table 7: Drivers for circular economy in the construction industry

Category	Drivers	Source
Economic Benefits	Reduction of material resource consumption	Aigwi et al. (2023)
	Increased economic benefits	
	Extends building useful life	
	Increases affordable housing	
	Increases building usability	
	Incentive circular business models	Munaro et al. (2023)
	Establish a physical and online marketplace for material circularity	
	Incentive and assurance schemes for reused/recycled products	
	Encourage and exploit the financial benefits of the data and sharing economy	
	Explore the costs of various low-waste building techniques and potential scalability	
Social Benefits	Urban regeneration	Aigwi et al. (2023)
	Improve the quality of life	
	Reduced crime incidents	
	Boosts social value	
	Empower community action and involvement	
	Encourage tourism	
	Improve resilience	
Cultural and Historical Benefits	Sense of place and identity	Aigwi et al. (2023)
	Preserve cultural and historical values	
	Preserve cultural and historical heritage values	
	Retain cultural materials	
	Preserve historical qualities and aesthetics	
	Reduces landfill demolition waste	Aigwi et al. (2023)

Environmental Benefits	Energy efficiency	
	Low carbon commission	
	Less energy consumption	
	Reduces greenhouse gas emissions	
	Promote land use plan	
	Reduce environmental pollution and disturbance	
Informational Drivers	Improve CE awareness and research	Munaro et al. (2023)
	Awareness through electronic media, raising CE campaigns, and advertisement	
	Disclosure of best practice case studies, seminars, and workshops on sustainable development	
	More CE academic research and projects should be done by developing guidelines	
Institutional Drivers	Establish a strategic and educational vision	Munaro et al. (2023)
	Establish on-site inspections and audits before demolition to reduce CDW	
	Establish a culture of sorting on-site, separating, collecting, and treating the CDW	
	Encourage designers and builders to reuse CDW and prioritize upcycling rather than recycling	
	Create links between demolition contractors and stockists to incentivize deconstruction and materials salvage	
	Benchmarking companies engaged in recovery and sale of secondary materials to enhance competition, supply, and diversity in offers	
	Develop assigned responsibilities and long-term circular value chains between stakeholders	
	Training stakeholders to increase the understanding of CE and sustainability	
Political Drivers	Public financial aid	Munaro et al. (2023)

	Government incentive to kick-start the industry, subsidize or create the shared storage facility	
	Funding for innovation, CE research, and subsidizing technology for CE	
	Circular criteria in public procurement (e.g., a minimum percentage of recycled materials)	
	Policy incentives, or credit in environmental assessment methods/tools	
	Fiscal and regulatory actions	
	Regulatory actions for reduced GHG emission and metrics for embodied carbon in buildings	
	Policy system that guides and supervises CDWM, including CDW reporting mandatory	
	Reduction of taxes on labor and an increase of taxes on the use of primary raw materials	
	Tax exemptions for goods produced by secondary materials	
	Penalties for non-compliance and incentives for compliance with CE regulations	
	Higher landfill charge	
Technological Drivers	Guidelines and tools for circular buildings	Munaro et al. (2023)
	Early collaboration and inclusion of waste management in project sustainability tools and building control process	
	Better management of resource flows and end-of-waste criteria for CDW at construction sites	
	Development of symbiosis and enabling technologies for CDW management	
	Development of guidance and tools for the assessment of building circularity	
	Improving certification of recovered materials to reduce uncertainty and lack of trust	
	Mandatory application of LCA/LCC for the whole life cycle of a building	

	Establishment of effective and reliable ICT solutions	
	Creating datasets for BIM and exploring the feasibility of BIM in conducting other types of performance analysis for resource management	

9.2 Appendix II

Table 8: Barriers for circular economy in the construction industry

Category	Barriers	Source
Technical barriers	- Structural integrity	Aigwi et al. (2023)
	- Functional changeability	
	- Uncertainty of existing building information	
	- Nature of building foundation	
	- Availability of materials	
	- Fire protection	Eisele et al. (2020)
	- Technical requirements	
	- Static requirements	
	- Parkin spaces (could be regulatory as well)	
	- Room quality	
	- Flexibility	
	- Lack of information about Desing for Disassembly, green design, and end-of-life products	Munaro and Tavares (2023)
	- Lack of knowledge about circular tools (EPDs, Material Passports, certifications, etc.)	
	- Ineffective CDW management	
	- Recycling practices are thwarted by limited separation of materials, logistical barriers, and lack of process to produce easily disassembled products	
	- Lack of tools for identifying, classifying, and certification of salvaged materials	
	- Complexity of materials and building composition (several layers and modifications during its lifespan)	
	- Lack of standardized spatial geometries and limited visualization for design for disassembly	
	- Lack of effective green building design development	
	- Lack of quality and availability of data (privacy, trust, ownership, access)	
Economic barriers	- High maintenance cost	Aigwi et al. (2023)
	- Lack of incentives	
	- Market demand feasibility	
	- Uncertain return on investment	
	- The financial aspect of the asset is the most important	Charef et al. (2021)
	- Short term vision	
	- Low cost of standard construction & demolition practices	
	- Reuse/recycling uncompetitive (expensive)	

	- Low landfill cost	
	- Labor intensive effort	
	- Less manpower and more mechanization	
	- Estimation of deconstruction / sustainable end-of-life approach	
	- Additional design cost/time	
	- Attractiveness of conventional recycling	
	- Additional cost of principle adoption / new approach adaption cost	
	- Cost of hazardous component	
	- Insurance cost	
	- Additional cost for new roles, missions, tasks	
	- Additional costs for storage and transportation	
	- The pressure to get the project done	
	- Schedule issues	
	- Cost of tools and processes	
	- Cost for product technical data sheets	
	- Less choice – number of manufacturers working with this approach	
	- Difficulty to quantify and sale the approach	
	- Client willingness to pay up front	
	- Market: high competitiveness	
	- Uncertainty about the results	
	- Difficulty to break into the established markets dominated by industrial materials	
	- Market & business advantage demolition rather than deconstruction	
	- Market preparation	
	- The inadequate market value	
	- Lack of established second hand materials markets	
	- Lack of markets for a wide variety of C&D waste products	
	- Lack of recovery materials reprocessing facilities	
	- Lack of a structured platform for reclaimed materials	
	- Lack of demand / client demand for sustainable building, reverse logistics, deconstruction, design for disassembly, reuse	
	- Lack of demand for sustainable end-of-life	
	- Good coordination between demand with supply	
	- Barriers imposed by the governing business environment in the industry	

	- Drawbacks in sustainable building marketing processes	
	- Lack of marketing plan	
	- Research & development and certification cost	Charef et al. (2021), Munaro and Tavares (2023)
	- Economic efficiency	Eisele et al. (2020)
	- High availability and low costs of virgin raw materials	Munaro and Tavares (2023)
	- Under-developed/lack of market mechanisms for recovery/reuse of materials	
	- High costs of deconstruction, separating, treating, transportation, and storage of CDW	
	- High prices of recycled/reused materials/products	
	- Lack of reward and penalty schemes for CDW management operations	
	- Product prices do not take environmental costs into account	
	- Financial and risk aversion for circular business models	
	- Culture of rapid returns on investment and high prices for green buildings	
	- High investment costs of waste technologies	
Regulatory barriers	- Compliance with building code regulations	Aigwi et al. (2023)
	- Anti-adaptive reuse policies	
	- Lack of awareness	
	- Copyright	Eisele et al. (2020)
	- Accessibility	
	- Planning and building regulations	
	- Flexibility on the part of the authorities	
	- Lack of incentive and support to design for end-of-life (low pontifications for design for disassembly)	Munaro and Tavares (2023)
	- Lack of flexibility in the building codes and regulations	
	- Lack of EPD international standardization	
	- Lack of producer-based responsibility system and regulatory frame for integrated resource management	
	- Lack of a waste code to guide CDWM and discourage landfilling	
	- Lack of a tax system and standard quality for reclaimed materials	
	- Lack of laws to assign a minimum percentage of CDW for reusing and recycling	

	- Lack of land-use zoning and rational urban planning	
	- Lack of national goals, targets, and legal support system with a binding effect	
	- Lack of effective supervision from the government (qualified professionals and budget)	
Social barriers	- Unrealistic hypothesis	Charef et al. (2021)
	- Fear of additional construction cost	
	- Strong belief = waste management is more expensive	
	- Disbelief in the potential utility of a constructability program	
	- Culture of waste behaviour = waste is inevitable	
	- Consumer culture and perceptions for reclaimed materials, bad image of salvaged components (poor quality)	
	- Industrial world	
	- Bad image of prefabrication	
	- Evolving mores (aesthetic trend)	
	- The building lives badly socially	
	- Lack of awareness for the approach (deconstruction, sustainable building, etc.)	
	- Lack of motivation / priority / demand for a sustainable end-of-life approach	
	- Lack of awareness / popularity, deconstruction is not a hot topic	
	- Lack of common language and understanding	
	- Lack of awareness in reuse and recycling potentials	
	- Lack of understanding of sustainable building, deconstruction and sustainable end-of-life approaches	
	- Lack of understanding link between materials and IAQ	
	- Lack of awareness and understanding of the approach' benefits	
	- Lack of concern for the end-of-life	
	- Lack of care about risk associated to construction materials	
	- Lack of communication on sustainable end-of-life approach	
	- Low risk culture	
	- Lack of lateral thinking	
	- Ignorance of the life cycle thinking / linear view	
	- Lack of trust and acceptance of reclaimed components	

	- Lack of trust in non-conventional materials	
	- Lack of trust in data	
	- Lack of trust in builders (materials' substitution)	
	- Unfavourable business culture / quick return on investment	
	- Construction industry scepticism and tradition	
	- Natural resistance to change	
	- Builders and owners resistance to change	
	- Resistance to new technologies and innovation	
	- Manufacturers resistance to change	
	- Designers resistance to change	
	- Resistance to change of old generation	
	- Mentalities	
	- Materials' suppliers influence	
	- Influence of workers between them	
	- Negative public perception (lack of communication, trust, and awareness)	Munaro and Tavares (2023)
	- Social and behavioural aspects of modern consumerism	
	- Lack of thinking about buying a service instead of having the ownership	
Environmental barriers	- Site access	Charef et al. (2021)
	- Site dimension	
	- Storage facilities for reclaimed materials	
	- Quantity of polluted waste	
	- Use of finishing works	
	- Awareness, benefits, impacts	
	- Sustainable assessment	
	- Emission from transport	
	- Use of virgin feedstock	
	- Risk and contamination	
	- Emission load	Eisele et al. (2020)
	- Limited environmental management programs and facilities at academic institutions	Munaro and Tavares (2023)
	- Insufficient application of waste hierarchy (overemphasizing recycling)	
Management barriers	- Decision making and stakeholder participation	Aigwi et al. (2023)
	- Lack of planning	
	- Balance profit-making and continuity of local community life	
	- Lack of skilled tradesmen	
	- Tenant requirement	Eisele et al. (2020)
	- Basic organisation	
	- Lack of publicity and information campaigns	Munaro and Tavares (2023)

	- Conservative, competitive, and fragmented supply chains	
	- Lack of guidance and tools for the implementation/ assessment of circular buildings	
	- Lack of support for research, innovation, information, and business procurement strategies	

9.3 Appendix III

Table 9: Demand and supply factors affecting the general location choice of real estate
Source: (Rymarzak & Siemińska, 2012)

RE Type	Demand Factors	Supply Factors
Industrial space	- Number of consumers (buyers/clients) - Expected sales volume - Seasonality - Prices of substitute products - New household formations - Age composition of new households - Household income - Mortgage credit conditions	- Availability of natural resources (water, quantity, quality of minerals, agricultural, forest) and their prices - Availability of fuels (coal, oil, gas, electricity, fuel expandability, reserves) - Transportation methods and costs (water, rail, highway, air, access) - Human resources (wage rates, skill levels, productivity, availability) - Prices, productivity of production - Number and location of competitors - Prices of production components used in construction - Productivity of production and technology - Number of builders in the market - Builders' expectations for future sales - Demolitions - Credit conditions
Housing	- Population (number, growth rate, age) - Households (number, growth rate, number of people outside households, income levels, pattern of expenditure, rent-or-buy threshold) - Mortgage credit conditions - Prices of substitute units - Expectations about the future	- Prices of production components used in construction - Productivity of production and technology - Number of builders in the market - Credit conditions - Proximity of schools, transport networks, jobs - Builders' expectations for future sales - Demolitions
Retail space	- Population (number, density, growth rate, age and gender pattern, educational attainment) - Households (composition and size, income levels, average disposable income per capita) - Credit conditions and payment plans - Unemployment level - Internal, external migrations - Social mobility - Trend for delayed marriage and parenthood - Customer tastes and preferences - Prices of substitute products	- Proximity of transport networks - Retail saturation in area - Retail space vacancy rate - Growth rate of new outlets - Market share of individual retail facilities - Merchandise offered - Age of retail facilities - Technical standard of existing space - Parking capacity

Office space	- Unemployment level - Number of local firms - Type of business of local firms - Number of local firms (expanding or upgrading, ceasing business or leaving local market) - Number of new firms entering local market - Office space per employee (square feet)	- Number of existing office buildings - Office building pattern and size - Accessibility to the client – location vs housing estates and transport networks - Office space vacancy rate - New office facilities growth rate - Age, technical standard of existing space - Parking capacity - Recent absorption of space, including types of tenants or buyers - Market rents/sale prices - Developer expectations - Demolitions, conversions - Credit conditions

9.4 Appendix IV

Interview Protocol

Study Title: Conditions for Circular Building Transformation: A Framework for Project Selection.

Interviewer: [Your Name]
Date and Time: [Date]
Location: [Location, or Online]
Participant: [Interviewee Name, Company, Role in Company]

Introduction and Context

1. Introduction of the Project:
    - Goal of the Master's Thesis: I am exploring how circular principles can be applied in real estate development, specifically in the transformation of existing buildings. My aim is to understand the conditions necessary for successfully selecting and implementing circular projects.
    - Interview Duration: The interview will take approximately 45-60 minutes.
    - Confidentiality: The information will be anonymized and treated confidentially. You can choose not to answer any question or end the interview at any time.
2. Permission to Record: May I record the interview for the purpose of analyzing the results later?
3. Introduction of interviewee: Can you briefly describe to me your role in the company and your experience in project development?

Theme I: Circularity in Real Estate Development

Main Question:

1. Are you familiar with the concept of circularity in real estate?

Follow-up Questions:

- If Yes: Could you share what circularity in real estate means to you, especially when it comes to transforming existing buildings?
- If No: (Briefly introducing the idea of circularity) – Does this sound familiar, or have you come across anything similar in your work?
- What circular practices, if any, do you or your company already use in your projects?
- Could you name some examples?

Theme II: Project Evaluation and Selection Methods

Main Question:

2. How does your company decide which real estate development projects to go ahead with?

Follow-up Questions:

- Is there any method or criteria that is valued most? For instance, is economic feasibility usually a priority?
- Do you currently consider sustainability or circularity as part of the project selection criteria?
- Could you walk me through a recent project selection process?

Theme III: Integration of Circularity in Project Evaluation

Main Question:

3. Do you think adding circularity principles to the selection process would bring benefits?

Follow-up Questions:

- If Yes: Can you explain why you think so? And how would you suggest incorporating them?
- If No: Could you share why you feel that way?
- Is there anything you would change about the current selection process?

Theme IV: Relation between Selection Criteria and Circular Project Result

Main Question:

4. In your view, would adding circularity principles to the selection process make projects more circular in practice?

Follow-up Questions:

- Why or why not? Do you have examples from your experience?
- How important do you think it is to integrate circularity goals early on in the planning phase?
- What kind of support, and from whom, would project developers need to successfully implement circular projects?

Alternative main question of main question 3 is answered with "no":

5. If not through the project selection process, in what other ways do you think circularity could be integrated or enhanced in real estate development projects?

Follow-up Questions:

- What phases of a project's lifecycle do you think offer the best opportunities for increasing circularity?
- What kind of support, and from whom, would project developers need to successfully implement circular projects?

Conclusion

Main Question:

6. Is there anything else you would like to add or something we haven't discussed yet?

Thank You:

Thank you for your time and valuable insights. Your responses will greatly help me gain a better understanding of the conditions and challenges related to integrating Circular Economy into real estate project development.

9.5 Appendix V

Table 10: Themes, sub-themes & codes deduced from interview data analysis

Themes	Sub-themes	Codes
Economic feasibility & added value	Costs	- Urban Mining - Material pass - Investment of financial resources in project development - Economic efficiency parameters of project developments - Life-Circle-Analysis as an assessment tool for long-term influences - Maintenance/operation of circular buildings - Supply chain of circular processes - Development of costs based on circularity in projects - Return on investment
	Income	- Flexibility of circular project designs with regard to user requirements - Advantages of circular measures - User requirements for buildings - Quality requirements in real estate - Circularity as a publicity tool - Tenant requirements (or their development) of buildings - Change in value and rent - Repositioning of buildings after a transformation - Marketing of completed buildings - Aesthetic added value of old buildings/listed buildings - Transfer from one form of use to another of buildings - Demand for circular products - Social added value - Aspects of buying and selling
	Financing	- Verification/reporting on ESG and circular topics - Investment of financial resources in project development - Financing of project developments by means of banks or investors - Return on investment - Depreciation
	Risk	- Vacancy of rental space - Approval of construction projects from the building authorities - Additional challenge due to circularity in projects - Complexity of project developments - Repositioning of buildings after a transformation

		- Real estate at risk of becoming a stranded asset
	Taxes & subsidies	- CO2 emissions as environmental pollution - State funding (subsidies) for circular measures
Project Analysis	Accurate & transparent Data Management	- Evaluation of data in the project review process - Documentation and data collection as a valuable tool - Project-specific details - Relevance of data and information - (Non-)standardized acquisition processes - Failure/setback of circular measures
	Supplementary Analysis	- Pollutants in materials of old buildings - Optimization of processes and projects through circularity - Preservation in the course of circular building transformation - Structure or supporting structure of buildings - Safety requirements for people in old buildings/components - Evaluation of building statics - Disposal of waste - Inspection as a data verification measure - Environmental Social Governance - Due diligence as an auditing process - Scope of services provided by the creators of circular analyses - Support for the implementation of circular measures
	Early Integration of Circularity	- Planning phases and possibility to integrate circularity - Time frame exceeded for integration of measures in project development - Taking decisions - Success rate of circular measures - Continuous support of circular measures in project phases
	Preselection criteria	- Geographic location as a decision criterion - Storage and logistics on construction sites - Relevance and impact of building age - Project selection criteria
	Comparative Analysis	- New construction instead of transformation - Project size as a benchmark - Concept and design phase - Development of variants in the concept phase - Area gain or expansion of the gross floor area of projects
People & Knowledge	Corporate culture	- Strategy of project developers - Ideology as a driver for circularity - Motivation for integrating circular measures

		- Sustainable portfolio of project developers - Processes of project development companies - Circular vision - Goal of project developers
	Knowledge sharing	- Level of academic education and knowledge - Not convinced of circularity - Coordination of several parties / generations - Teamwork as a success factor - Collaboration between teams, project participants and players in the market - Generations of project developers in terms of age and work experience
	Expert Knowledge	- Involving experts and specialist planners on the topic of circularity - Project development as an iterative process
	Training & Education	- Level of academic education and knowledge - Workshops to identify circular possibilities
Technology & Innovation	Added components	- Raw materials/materials - Material cycles - Producers of materials and their role - Modular systems of materials and components - Separability of materials and components - Material take-back - Product as a service - Reuse of buildings, components and materials - Supply chain of circular processes - Demolition of existing structure / building parts - Component supplementation during project developments - Low-tech building as a concept for preservation - Market for circular processes - Dismantlability of materials and components
	Fragmented Understanding	- Urban Mining - Environmental influences and aspects - Material cycles - Demolition of buildings or parts of buildings - Energy consumption / savings as a measure of circularity - Awareness of circularity (and the added value of it) - Saving resources - Gutting the existing building as a measure for transformation - Building services in existing buildings
External factors & drivers	Regulations & EU Taxonomy	- Verification/reporting on ESG and circular topics - External requirements

		- Laws and regulations in the construction industry - Additional challenge due to circularity in projects - Regulation - EU taxonomy as a regulatory framework - Monument protection as a role model for circular building transformation - Politics as an influencer - Requirements of external parties for successful project implementation
	Certifications	- Acceptance of circularity and preservation of existing structures - Certification of buildings
	Requirements of architectural firms	- Requirements of external parties for successful project implementation
	Insurance	- Claims from insurance companies for buildings

9.6 Appendix VI

Focus Group Workshop

Study Title: Conditions for Circular Building Transformation: A Framework for Project Selection.

Interviewer: [Your Name]
Date and Time: [Date]
Location: [Location, or Online]
Participant: [Interviewee Name, Role in Company]

Introduction and Context

1. Introduction of the Project:
    - Goal of the Master's Thesis: I am exploring how circular principles can be applied in real estate development, specifically in the transformation of existing buildings. My aim is to understand the conditions necessary for successfully selecting and implementing circular projects.
    - Interview Duration: The workshop will take approximately 60 minutes.
    - Confidentiality: The information will be anonymized and treated confidentially. You can choose not to answer any question or end the interview at any time.
2. Permission to Record: May I record the workshop for the purpose of analyzing the results later?

Step I: Basis and starting point of the discussion

In my master's thesis, I have so far worked on several key steps to examine the integration of circularity into project development processes. First, I created the theoretical framework by analyzing existing research results, concepts and best practices on the topic of circularity and sustainability as part of a comprehensive literature study. Building on this, I conducted semi-structured interviews with experts from the construction and real estate industry in phase 1 of my empirical research. These interviews allowed me to gather practical insights and diverse perspectives. I then systematically analyzed, coded, and grouped the interview data thematically. Based on the insights gained, I derived specific recommendations for action that aim to integrate circularity into the project selection process in a practical and effective way.

Step II: Presentation and evaluation of results from Phase 1

In this step, the recommendations for action developed so far, which were derived from the literature study and the interviews, are presented. Participants rate these recommendations using two scales: **relevance** (how important is the recommendation for the integration of circularity?) and **feasibility** (how realistic is implementation in practice?). The aim is to collect feedback, set priorities and identify potential adjustments.

Relevance (1-5): How important is the recommendation?

- **1 Very unimportant**: The recommendation has little significance for the integration of circularity.
- **2 Somewhat unimportant**: The recommendation is relevant but has little influence on the process.

- **3 Neutral**: The recommendation is neither particularly important nor unimportant.
- **4 Somewhat important**: The recommendation is useful and makes a noticeable contribution to the integration of circularity.
- **5 Very important**: The recommendation is of central importance and an essential factor for success.

Feasibility (1–5): How realistic is implementation?

- **1 Very unrealistic**: The recommendation is currently hardly practicable or requires extreme effort.
- **2 Somewhat unrealistic**: The recommendation is difficult to implement but could work under special circumstances.
- **3 Neutral**: Implementation is possible but presents some challenges.
- **4 Somewhat realistic**: The recommendation is easy to implement but requires moderate effort.
- **5 Very realistic**: Implementation is straightforward and can be easily carried out with existing resources.

Recommendation for action	**Relevance (1-5)**	**Feasibility (1-5)**	**Comment**
Theme: Economic feasibility & added value			
Life Cycle Analysis (LCA): Project developers should integrate standardized LCA into project selection to account for long-term costs and savings, including operational expenses and reuse potential of materials.			
Reuseable Materials: High-quality materials and their reuse should be a fixed component of cost calculations. Tools like Madaster can help document and make the material value of buildings transparent.			
Subsidy Strategies: Consider subsidies in project evaluations, using a conservative assessment of their likelihood. Streamlining internal processes can minimize administrative burdens.			
Realistic Rental Income Expectations: Avoid assuming higher rental income or increased sales values solely based on circular construction. Expert opinions are inconsistent, and tenant preferences vary greatly.			
Long-Term Perspectives: Include potential future developments, such as carbon taxes, in risk assessments but not as the foundation for current decisions.			

Monitor Political Changes: Stay updated on tax and regulatory developments to adjust strategies proactively and take advantage of emerging opportunities.			
Risk-Based Subsidy Assessment: Subsidies should be included in profitability calculations but assigned a likelihood to minimize financial uncertainty.			
Conservative Vacancy Rate Adjustment: Sustainable buildings attract tenants, especially those adhering to ESG criteria, which can justify lower vacancy rate assumptions.			
Approval Risk Analysis: Circular projects are more likely to receive permits but require early preparation for component verification processes.			
Incorporate Financing Requirements: Include the sustainability and circularity criteria required by banks and investors in profitability assessments to secure favorable conditions.			
Document Material Value: Projects with well-documented material value and resource passports can benefit from better financing terms, including depreciation advantages and material valuation.			
Theme: Project selection			
Location and Building Age: Systematically consider these factors during the initial project evaluation phase, including regional characteristics and restrictions.			
Advanced Assessment Methods: Use Quick Checks and ESG Due Diligence (ESG-DD) as standard tools to analyze circularity and sustainability potential comprehensively.			
Variant Analysis: Include systematic comparisons of multiple options, supplemented by LCAs, as a standard practice in the design phase.			
Early Integration of Circularity: Define circularity objectives early and embed them consistently in the			

planning and decision-making processes.			
Digital Tools: Use BIM models and material databases to systematically document and manage material information.			
Theme: People & Knowledge			
Intergenerational Teams: Combine the practical experience of older professionals with the innovative approaches of younger generations for a balanced perspective.			
Training and Development: Include circularity-focused training as a mandatory part of professional growth.			
Leverage Expertise: Utilize both internal teams for quick decisions and external consultants for cutting-edge knowledge and best practices.			
Corporate Strategy: Establish circularity as a core corporate value to enhance project implementation and company reputation.			
Theme: Technology & Innovation			
Holistic Thinking: Train teams to go beyond conventional methods, focusing on large-scale transformations, material cycles, and resource conservation.			
Innovative Materials and Concepts: Prioritize circular materials, timber construction, modular components, and "Product as a Service" models early in project planning.			
Theme: External factors & drivers			
Regulatory Compliance: Monitor developments such as the EU taxonomy and integrate circularity principles into project phases to ensure compliance.			
Sustainability Goals: Define sustainability and circularity objectives early to attract architects and planners who prioritize such criteria.			
Certification Use: Use certifications like LEED or DGNB as tools to reflect true sustainability rather than just for marketing purposes.			
Insurance Considerations: Align with insurers early to address			

sustainability requirements and ensure project insurability.			

Step III: Discussion

In the next step, the participants will discuss the individual recommendations one after the other, give feedback from their practical experience and add possible suggestions for improvement. This discussion serves to further specify the recommendations for action, clarify open questions and make practical adjustments.

9.7 Appendix VII

Table 11: Quantitative Data Analysis from Phase 2

No.	Recommendation for action	Relevance (1 = very unrelevant, 5 = very relevant)								Feasibility (1 = very unrealistic, 5 = very realistic)								
		EXP10	EXP11	EXP12	EXP13	EXP14	EXP15	EXP16	Mean Value	EXP10	EXP11	EXP12	EXP13	EXP14	EXP15	EXP16	Mean Value	Notes
1.	**Economic feasibility & added value**																	
1.1	**Life cycle analysis as a basis for decisions**	5	4	4	4	4	4		**4,2**		3	3	3	4	4		**3,4**	
1.2	**Evaluate reuseable materials**	5	4	4	4	4	2		**3,8**		3	4	3	2	2		**2,8**	
1.3	**Do not have unrealistic expectations of higher rental income**	5	3	5	3	5	4		**4,2**	5		3	2	4	5		**3,8**	
1.4	**Integrate financing requirements into the profitability calculation**	4	3,5	4	4	4	5		**4,1**	3	4	4	5	4	4		**4,0**	
1.5	**Include material value and building resource passport as calculative advantages**	1	4	4	2	4	3		**3,0**		3,5	4	2	2	2		**2,7**	
1.6	**Adjust vacancy rates conservatively**	4	5	3	2	4	4		**3,7**	2	4	3	4	5	5		**3,8**	EXP10: YES and NO --> improves the prospect, but also simply correlates with new building quality EXP11: but nevertheless the cost aspect is important
1.7	**Analyze approval risk**		5	4	4	3	5		**4,2**		2	4	4	3	2		**3,0**	
1.8	**Consider long-term perspectives**	5	3	3,5	3	2	4		**3,4**	3	3	1,5	2	2	2		**2,3**	
1.9	**Monitor political developments**	5	4	3,5	5	4	5		**4,4**	2	4	1	4	4	2		**2,8**	
1.10	**Develop strategies for getting subsidies**	5	4	5	5	4	3		**4,3**	1	2	3	4	4	4		**3,0**	EXP10: important for profitability, but often changes EXP11: cost aspect, the CO2 tax is set to rise significantly in the next few years
1.11	**Assess subsidies with risk**		4	4	4	4	4		**4,0**		2	3	4	5	5		**3,8**	
2.	**Project Analysis**																	
2.1	**Accurate and transparent data management**	5		3	4	3	4		**3,8**	2		3	3	2	1		**2,2**	EXP11: more for technical asset management
2.2	**Supplementary analysis**	5	5	3	5	4	5		**4,5**	1	5	3	4	4	4		**3,5**	EXP10: ESG-DD not always meaningful
2.3	**Early integration of circularity**	4	4	5	3	3	4		**3,8**		4	5	3	2	4		**3,6**	EXP13: constant changes require flexibility
2.4	**Preselection criteri**	**5**	3	4	5	5	5		**4,5**	1	5	4	5	5	5		**4,2**	
2.5	**Comparative analysis**	5	5	5	5	4	5		**4,8**	1	5	5	4	5	5		**4,2**	EXP15: must be decided in LPH1-2
3.	**People & Knowledge**																	
3.1	**Corporate culture**			2	4	4	3		**3,3**			2	5	5	2		**3,5**	EXP13: Corporate value versus implementation
3.2	**Knowledge sharing**	5	2	4	5	2	2		**3,3**	3	3	2	4	2	5		**3,2**	EXP13: Compromises difficult with different points of view and different seniority
3.3	**Expert knowledge**	5	3	4	5	4	3		**4,0**	2	3	2	5	4	5		**3,5**	EXP11: Cost aspect must be considered and evaluated
3.4	**Training and education**	4	3	3	5	2	2		**3,2**	2	3	2	5	2	3		**2,8**	EXP11: Time aspect
4.	**Technology & Innovation**																	
4.1	**Adress circularity for added components**	4		5	5	4	4		**4,4**	3		4	3	1	4		**3,0**	
4.2	**Training and awareness raising for holistic approaches**	4	3		5	1	4		**3,4**	2	2		3	3	3		**2,6**	
5.	**External factors & drivers**																	
5.1	**Regulations and EU-Taxonomy**	5	3	4	5	3	5		**4,2**	3	3	2	4	3	4		**3,2**	EXP11: Development must be constantly monitored
5.2	**Certification**	5	4	4	4	5	5		**4,5**	1	4	2	4	5	4		**3,3**	
5.3	**Requirements of architectural firms**	4	4	4	4	4	5		**4,2**	2	3	4	4	4	5		**3,7**	
5.4	**Insurance**		3	4	3	2	3		**3,0**		3	3	5	4	2		**3,4**	EXP14: Insurance is generally important – but not explicitly for sustainability

9.8 Appendix VIII

Delft University of Technology

HUMAN RESEARCH ETHICS

INFORMED CONSENT

(English Version: January 2022)

Participant Information/Opening Statement

You are being invited to participate in a research study titled "Circular Principles for Real Estate Development: Adjustment for Project Selection & Its Application in Practice." This study is conducted by Ana-Magdalena Jax from TU Delft as part of her Master's thesis research.

Purpose and Potential Outcomes of the Study

This study aims to explore how circular economy principles can be integrated into project selection criteria for real estate development. By refining these criteria, this research seeks to identify actionable insights that could contribute to more circular real estate development practices. The results are expected to contribute to academic knowledge and offer practical recommendations for the industry.

Role of TU Delft and Third Parties

TU Delft provides supervision and guidance for this study, which is solely funded by the institution itself, without involvement from any third-party funders or organizations.

Participant Profile

The study involves experienced professionals in real estate development. Participants are selected based on their expertise in real estate project management, sustainability, or circular economy practices.

Participation Details

As a participant, you will be asked to participate in a semi-structured interview. This will involve discussing your experiences, practices, and insights relevant to project selection and circular economy principles in real estate development. The interview will take approximately 45-60 minutes and will be conducted either via Microsoft Teams.

Personal Data Collection and Management

Data collected during the interview will include your responses, which may contain Personal Identifiable Information (PII). This data will only be used for research purposes, including publication and potential inclusion in teaching materials.

- Confidentiality and Data Security: All personal information collected will be stored securely on secure cloud storage services. Your responses will be anonymized, meaning identifying details will be removed to protect your identity.
- Access and Use of Data: Only the researcher and her supervisors will have access to identifiable data.
- Data Archiving: Research data will be securely stored until the master thesis is finished, after which it will be archived or securely deleted.

Risks and Mitigation Measures

The risks associated with this study are minimal. However, if any reputational concerns or sensitive topics arise, your information will be anonymized, and confidentiality will be maintained.

Right to Refuse and Withdraw

Participation is voluntary. You may choose to skip any questions and withdraw from the study at any time without penalty.

Data Access, Rectification, or Erasure

You have the right to request access to your data, make corrections, or request erasure at any stage during the research process.

Compensation

No monetary compensation is provided for participation.

Contact Details

For any questions or concerns, please contact the Corresponding Researcher, Ana-Magdalena Jax

Explicit Consent points

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [*DD/MM/YYYY*], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: A semi-structured interview, recorded via audio and video. The recordings will be transcribed into text, and the original recordings will be securely deleted after transcription.	☐	☐
4. I understand that I will not be compensated for my participation.	☐	☐
5. I understand that the study will end in January 2025.		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves the following risks minimal risk. In the case of any discomfort, I can request to pause or stop the interview at any time.	☐	☐
7. I understand that participating in the study involves the collection of my personally identifiable information (PII) (e.g., my name, job title) and personally identifiable	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
research data (PIRD) in the form of interview responses. This data will be anonymized to protect my identity.		
8. I understand that, under GDPR legislation, sensitive data (e.g., political views) will not be collected during this study.	☐	☐
9. I understand that the following steps will be taken to minimize the risk of a data breach and to protect my identity: • Anonymization of data through pseudonyms in transcripts • Secure data storage with limited access • Data access limited to the research team, with no external sharing of identifiable information	☐	☐
10. I understand that personal information collected about me that can identify me, such as e.g. my name, will not be shared beyond the study team.	☐	☐
11. I understand that the (identifiable) personal data I provide will be destroyed after the research is finished in January 2025.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
12. I understand that after the research study the de-identified information I provide will be used and for a master thesis.	☐	☐
13. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
16. I give permission for the de-identified data, included in the master thesis, that I provide to be archived in the TU Delft repository so it can be used for future research and learning.	☐	☐

Signatures

_____	_____	_____
Name of participant [printed]	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name [printed]	Signature	Date

Study contact details for further information: Ana-Magdalena Jax, +4369917092819, ajax@student.tudelft.nl