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# DRIVERS AND BARRIERS IN CIRCULAR ECONOMY TRANSITION AND EMERGING INNOVATION ECOSYSTEMS

## Case Peittoo Circular Economy Park

Master of Science Thesis
Faculty of Management and Business
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# ABSTRACT

Roosa Harjula: Drivers and Barriers in Circular Economy Transition and Emerging Innovation Ecosystems – Case Peittoo Circular Economy Park
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The urgent need to address the prevalent environmental issues – such as climate change, biodiversity loss, and resource depletion – calls for drastic societal shifts. To transition to a circular economy from the linear model, systemic changes across industries are required. Circular economy parks are considered to carry a significant potential in the transition by transforming the conventional focus on individual businesses into inter-organisational collaboration and fundamentally revolving around circular economy practices at its core. However, the term circular economy park is largely absent in academic literature. This study investigates the development of a circular economy park, which incorporates two essential concepts: circular economy and innovation ecosystems. Thus, this study aims to empirically identify the drivers and barriers that impact the transition to a circular economy and the emergence of an innovation ecosystem, while also looking into the synergies between these two concepts.

To meet the research objectives, a qualitative embedded case study with elements of action research was conducted on a circular economy park in Finland. The primary data consisted of semi-structured interviews and group discussions with the actors of the circular economy park and representatives of the public sector. The primary data were complemented with secondary data, including case reports, brochures, governmental agency websites, and a database. An abductive thematic analysis was carried out to explore and uncover patterns and themes in-depth as well as gain a comprehensive understanding of the factors impacting the circular economy and innovation ecosystem emergence.

The key findings indicate that the factors impacting the emergence of the innovation ecosystem largely cover the internal dynamics of the circular economy park, whereas factors regarding the circular economy focus on the external dynamics of the park. The barriers are multi-faceted of which some create tensions, complicating the process to overcome them. Most drivers and barriers impacting the transition to a circular economy had to do with regulations, market dynamics, and societal forces. The growing awareness and demand for circularity, economic considerations, and tightening regulations drive the transition to the circular economy. Economic factors in decision-making are prioritised over environmental matters. This, combined with the high initial and processing costs of circular economy as well as customers being unwilling to pay more for sustainable solutions, are significant barriers to the circular economy transition. In waste management, recycling is the most widely adopted circular practice, overshadowing the importance of waste prevention. The emergence of the innovation ecosystem is mainly driven by economic benefits gained from innovation activities and information sharing. The ecosystem emergence is obstructed by several barriers, including the lack of value proposition, the absence of an orchestrator, fierce competition, and reluctance to share information and other resources. Another significant barrier is the operators' actions being too similar, and the lack of synergies thereof. Thus, there is a considerable need for new entrants and specialisation.

This study contributes to innovation ecosystem literature in the context of circular economy. The study puts forward a framework for factors impacting the circular economy and a novel categorisation for the drivers and barriers in the innovation ecosystem emergence. Additionally, it offers a novel contribution to the field by presenting the development of the circular economy park consisting of two processes: circular economy transition and innovation ecosystem emergence, while providing empirical evidence and a comprehensive understanding of drivers and barriers.

Keywords: circular economy, driver and barrier, innovation ecosystems, innovation ecosystem emergence, industrial waste management, inter-organisational collaboration

# TIIVISTELMÄ

Roosa Harjula: Ajurit ja esteet kiertotalouteen siirtymisessä ja innovaatioekosysteemien emergenssissä – Case Peittoon kiertotalouspuisto
Diplomityö
Tampereen yliopisto
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Kiireellinen tarve puuttua vallitseviin ympäristöongelmiin – kuten ilmastonmuutokseen, luonnon monimuotoisuuden vähenemiseen ja luonnonvarojen ehtymiseen – vaatii merkittäviä yhteiskunnallisia muutoksia. Lineaarisesta mallista kiertotalouteen siirtyminen edellyttää systeemisiä muutoksia kaikilla eri toimialoilla. Suuntaamalla huomion yksittäisistä liiketoiminnoista organisaatioiden väliseksi yhteistyöksi, jossa kiertotalouden harjoittaminen on keskiössä, kiertotalouspuistojen katsotaan sisältävän merkittävää muutospotentiaalia. Termi kiertotalouspuisto puuttuu kuitenkin suurilta osin tieteellisestä kirjallisuudesta. Tässä tutkimuksessa tarkastellaan kiertotalouspuiston kehitystä, joka sisältää kaksi olennaista käsitettä: kiertotalous ja innovaatioekosysteemit. Tämän tutkimuksen tavoitteena on siis empiirisesti tunnistaa kiertotalouteen siirtymiseen ja innovaatioekosysteemin syntymiseen vaikuttavat ajurit ja esteet sekä tarkastella näiden kahden käsitteen synergioita.

Tutkimustavoitteiden saavuttamiseksi Suomessa sijaitsevasta kiertotalouspuistosta tehtiin laadullinen tapaustutkimus, joka sisälsi elementtejä toimintatutkimuksesta. Tutkimusdata koostui ensisijaisesti puolistrukturoiduista haastatteluista ja ryhmäkeskusteluista kiertotalouspuiston toimijoiden ja julkisen sektorin edustajien kanssa. Primääridataa täydennettiin sekundääridatalla, joka sisälsi erinäisiä raportteja, esitteitä, valtion virastojen verkkosivut ja tietokannan. Abduktiivisen teema-analyysin avulla pyrittiin tutkimaan ja paljastamaan malleja ja teemoja syvällisesti sekä saada kattava käsitys kiertotalouteen siirtymiseen ja innovaatioekosysteemin syntymiseen vaikuttavista tekijöistä.

Keskeisimmät havainnot osoittavat, että innovaatioekosysteemin syntymiseen vaikuttavat tekijät kattavat suurelta osin kiertotalouspuiston sisäisen dynamiikan, kun taas kiertotaloutta koskevat tekijät keskittyvät puiston ulkoiseen dynamiikkaan. Esteet ovat monitahoisia, joista osa luo jännitteitä ja vaikeuttaa niiden selättämistä. Suurin osa kiertotalouteen siirtymiseen vaikuttavista ajureista ja esteistä liittyivät regulaatioon, markkinadynamiikkaan ja yhteiskunnallisiin voimiin. Kiertotalouteen siirtymistä ohjaavat ensisijaisesti kasvava tietoisuus ja kysyntä kiertotaloudesta, taloudelliset näkökohdat ja tiukentuva sääntely. Päätöksenteossa taloudelliset tekijät asetetaan ympäristöasioiden edelle, mikä yhdistettynä kiertotalouden korkeisiin investointi- ja käsittelykustannuksiin sekä asiakkaiden haluttomuuteen maksaa kestävistä ratkaisuista enemmän, ovat merkittäviä esteitä kiertotalouteen siirtymiselle. Jätteenkäsittelyn yrityksissä kierrätys on yleisin kiertotalouden strategia, joka jättää varjoonsa jätteen ehkäisyn tärkeyden. Innovaatioekosysteemin syntyä ohjaavat pääasiassa innovaatiotoiminnasta ja tiedon jakamisesta saatavat taloudelliset hyödyt. Ekosysteemin syntyä jarruttavat useat esteet, kuten arvolupauksen puute, orkestroinnin puuttuminen, kova kilpailu ja haluttomuus jakaa tietoa ja muita resursseja. Toinen merkittävä este on toimijoiden liiallinen samankaltaisuus ja tästä johtuva synergioiden puute. Uusille tulokkaille ja erikoistumiselle on siis huomattava tarve.

Tämä tutkimus edistää innovaatioekosysteemikirjallisuutta kiertotalouden kontekstissa. Tutkimus esittää viitekehyksen kiertotalouteen vaikuttaville tekijöille ja uudenlaisen luokituksen innovaatioekosysteemin syntymisen ajureille ja esteille. Lisäksi se tarjoaa uudenlaisen kontribuution alalle kuvailemalla kiertotalouspuiston kehitystä, joka koostuu kahdesta prosessista: kiertotalouteen siirtymisestä ja innovaatioekosysteemin emergenssistä, tarjoten samalla empiiristä näyttöä ja kattavan ymmärryksen ajureista ja esteistä.

Avainsanat: ajuri ja este, innovaatioekosysteemi, innovaatioekosysteemin emergenssi, kiertotalous, organisaatioiden välinen yhteistyö, teollisen jätteen käsittely

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# PREFACE

Five years ago, writing the master's thesis seemed like an impossible task and felt like a distant future goal. Yet, here I am, finished writing my thesis! I could not be prouder of myself, and I am all excited to see what the future holds for me.

First and foremost, I would like to express my deepest gratitude to my supervisors, Antero and Jukka. Their expertise, insightful feedback, and guidance have been invaluable throughout the research process. All the supervisor meetings we had, are greatly appreciated; conversations with you provided direction and notably improved the quality of the thesis. Additionally, I would like to thank our research team for peer support, and faculty for providing me the opportunity to work on the project. Thank you to all interviewees for contributing and making this thesis possible.

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This thesis marks the end of my academic journey, for now.

Oxford, 31 July 2024

Roosa Harjula

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# LIST OF SYMBOLS AND ABBREVIATIONS

| | |
|---|---|
| BAT | Best Available Technique |
| CE | Circular Economy |
| IPCC | Intergovernmental Panel on Climate Change |
| RDI | Research, Development & Innovation |

# 1. INTRODUCTION

## 1.1 Background of the Study

Climate change is affecting every region on this planet, and actions across all sectors are needed to ensure a liveable and sustainable future for current and upcoming generations (IPCC, 2023). Due to the unsustainable consumption of our planet's resources, we are running out, and by 2050, the amount of natural resources required to uphold current lifestyles would be equivalent to nearly three planets (United Nations, 2023). The greenhouse effect occurs naturally, and has kept the average temperature on earth around 15°C (McNall, 2011, p. 4; Richardson, Steffen & Liverman, 2011, p. 4; NASA, 2023). However, human actions significantly increase the amount of greenhouse gases which lead to global warming and climate change (McNall, 2011; NASA, 2023), meaning that humans have notably amplified the natural greenhouse effect, well beyond its typical levels. According to IPCC (2023), greenhouse gas emissions continue to rise, and the current actions and plans are not sufficient to address the challenges of climate change. Reducing greenhouse gas emissions requires rapid and far-reaching changes (IPCC, 2023), and companies hold a key position in this (Falcke, Zobel & Comello, 2023).

It is unequivocal that the current linear 'take-make-dispose' system that has dominated the global economy for centuries is to a great extent responsible for many environmental issues, such as greenhouse gas emissions, resource depletion, and biodiversity loss (Hobson, 2020; Chizaryfard, Trucco & Nuur, 2021; Konietzko, 2021). Strictly speaking, today's linear economy is not sustainable nor resource efficient (Ellen MacArthur Foundation, 2013, 2015), and it is nearing its physical limitations (Suchek et al., 2021). The circular economy (CE) has been introduced as an alternative model for the linear economy (Ghisellini, Cialani & Ulgiati, 2016; Konietzko, 2021), and as a solution to address these challenges to tackle climate change (Ellen MacArthur Foundation, 2013, 2015). The circular economy is perceived to be an efficient concept to cut down greenhouse gas emissions, reduce material use, and eliminate waste (Stahel, 2016; M. Yang et al., 2023). However, the CE requires a systemic change in companies, industries, as well as economies, and as such cannot be obtained solely through individual attempts (Chizaryfard, Trucco & Nuur, 2021, p. 495). Similarly, other scholars assert that a successful implementation of CE necessitates a broad stakeholder collaboration, execution of new

business models, and as previously highlighted, a systemic multi-level change (Goyal, Chauhan & Mishra, 2021; Asgari & Asgari, 2023).

Waste management holds a key role in transitioning to circular economy (Fellner et al., 2017; Nowakowski & Mrówczyńska, 2018), but the current practices of waste collection and management do not align with the CE concept (Zhang et al., 2019; Salmenperä et al., 2021). The current waste management practices are mainly still driven by the linear model where a wide range of waste ends up in a landfill or is incinerated, both of which remove the materials from circulation or destroys them (Lee et al., 2017, p. 16). In 2020, 2135 million tonnes of waste were generated in the EU, of which 39.9 % were recycled and 32.2 % landfilled (Eurostat, 2023b). One of the core principles of the CE is closing the resource loops (Bocken et al., 2016; Van Opstal & Borms, 2023) which is also a key element in the EU's Circular Economy Action Plan (Tomić & Schneider, 2020), working as a countermeasure against the final disposal of waste by keeping materials in circulation. The aim of 'closing loops' is to shift away from the linear model towards a circular one where resources are recycled and reused, minimising waste and reducing the need to extract new raw materials (Bocken et al., 2016; López Ruiz, Roca Ramón & Gassó Domingo, 2020). While Finland is aiming to become a forerunner in the circular economy (Salmenperä et al., 2021), in 2022, Finland had the lowest circularity rate, the share of circular use of materials to overall material input, in the EU with 0.6 % while the EU as a whole reached 11.5 % (Eurostat, 2023a).

Businesses are, moreover, called for innovations in products, services, and processes to achieve reductions in greenhouse gas emissions (Olson, 2013; Varadarajan, 2017; Demirel & Kesidou, 2019; Falcke, Zobel & Comello, 2023). Innovations are acknowledged as one of the core elements of managing sustainability issues (Maier et al., 2020; Sultana & Turkina, 2023). While innovations play a vital role, collaboration is indispensable just as in the CE. Innovations are developed collaboratively, combining the efforts of various stakeholders in the aim of creating value (Visscher, Hahn & Konrad, 2021). To transform waste management practices into a more sustainable form, inventive solutions are demanded. Konietzko (2021, p. 28) proposes that an ecosystem perspective is essential in order for organisations to innovate towards the CE. At this juncture, the relevance of innovation ecosystems becomes apparent. Nonetheless, there is conceptual ambiguity regarding innovation ecosystems, as authors offer differing definitions, and furthermore, the concept is inconsistently used (Oh et al., 2016; Ritala & Almpanopoulou, 2017). An innovation ecosystem can be defined as an interconnected network of actors that collaborate and create value by incorporating innovative approaches (Autio &

Thomas, 2014, p. 205). In an innovation ecosystem, actors engage and collaborate to work towards a shared goal (Sultana & Turkina, 2023).

The term of circular economy park is largely absent in academic research. In this study, a circular economy park is a specialised zone for a wide range of circular economy activities where businesses collaborate to share resources and materials. One of the key elements of circular economy parks is that one company's waste becomes another's resource (Mäkelä & Marjamaa, 2023, p. 477) which supports the strategy of 'closing the resource loop'. In this study, circular economy parks are viewed to encapsulate the synergy of circular economy and innovation ecosystems, given the emphasis on collaborative and innovative circular economy solutions in waste management.

This study examines the development of a circular economy park and analyses the factors influencing its development. The study employs a qualitative embedded case study approach to investigate a circular economy park specialised in processing industrial by-products and waste. To provide clarity, the development of the circular economy park is divided to consist of two main concepts: circular economy and innovation ecosystems. Thus, these factors, namely drivers and barriers, are explored independently for both concepts. In the fast-expanding fields of circular economy and innovation ecosystems, this study aims to investigate the synergies between these two large-scale concepts. Although scholars recognise the potential of ecosystems in circular economy (e.g., Aarikka-Stenroos, Ritala & Thomas, 2021), the intersection has not been extensively explored as the ecosystem literature has mostly emphasised economic value creation (Wolff et al., 2023). As the transition from a linear economy to a circular entails systemic cooperation and inter-organisational collaboration (Paavilainen, Heikkinen & Kujala, 2021), the ecosystem perspective was considered valuable.

Despite the importance of waste management in a circular economy, a scarcity of studies has examined it, particularly practical applications of circular economy in waste management (Ranjbari et al., 2021). In order to advance circular economy practices in waste management, a comprehensive understanding of drivers and barriers is necessary. Yet, rigorous empirical studies of factors that hinder the successful transition to a circular economy in companies are sparse (Mishra, Singh & Govindan, 2022). Moreover, Salmenperä et al. (2021) point out that only few studies have addressed the critical factors in the transition to a circular economy in waste management. Thus, the study delves into the drivers and barriers of circular economy from the perspective of waste management companies.

A holistic view of innovation ecosystems is still lacking (Yaghmaie & Vanhaverbeke, 2019; Ngongoni, Grobbelaar & Schutte, 2022). Moreover, there is a limited number of empirical studies on the emergence of innovation ecosystems (Pushpananthan & Elmquist, 2022; Thomas, Autio & Gann, 2022). The research of innovation ecosystems has primarily focused on emergence barriers faced by single actors, overlooking the dynamic counterforces that obstruct the emergence of entire ecosystems, and is lacking a comprehensive understanding of obstructing factors (Almpanopoulou, Ritala & Blomqvist, 2019). To fill the research gap, a pivotal focus of this study is to examine how an innovation ecosystem comes into existence and what factors drive and inhibit the emergence. While the research on innovation ecosystems has mainly studied them through the lens of a focal firm (Oskam, Bossink & De Man, 2021), this study focuses on obtaining a comprehensive understanding of primary drivers and barriers of emerging innovation ecosystems on an inter-organisational level. The literature predominantly investigates existing ecosystems, offering an ex-post understanding of them (Pushpananthan & Elmquist, 2022). This study, however, adopts an ex-ante perspective on the emergence.

## 1.2 Research Objective, Questions, and Scope

To bridge the research gaps, this study adopts an explorative and descriptive embedded case study, focusing on multiple companies within a Circular Economy Park alongside public and governmental organisations. The study investigates innovation ecosystems in the circular economy context, primarily addressing waste management practices, seeking to contribute to the fields of circular economy and innovation ecosystems on inter-organisational collaboration. As understanding sustainability challenges requires a holistic and interdisciplinary approach (Salminen, Heikkinen & Kujala, 2023), the focus of the study is on both innovation ecosystems and circular economy. The purpose of this study is to discern factors impacting the emergence of an innovation ecosystem and the transition to a circular economy, namely drivers and barriers, on a practical level in waste management. Thus, the study carries a dual focus, with a specific emphasis on inter-organisational perspectives. As an innovation ecosystem is a network of actors that collaborate with each other, involving various actors, and thus, understanding the early dynamics of the innovation ecosystem is crucial when identifying the factors affecting the emergence. Due to climate change, resource depletion, and environmental degradation, systemically adopting circular economy practices has become vital and immediate efforts are required. Thus, there is an urgent need for collaborative initiatives and innovative

solutions in industrial and economic processes to tackle the prevalent issues where circular economy parks hold an important role.

The research questions derived from the research objectives with the intention of obtaining a comprehensive outlook on the topic. The previously mentioned dual focus leads to the division of distinct research questions and emphasises the systemic interlinkage of the circular economy and innovation ecosystems, underscoring their dependence. Implementing a circular economy in waste management, through measures such as efficient utilisation of waste as a resource and prevention of waste generation, can significantly contribute to reducing greenhouse gas emissions across various sectors (EEA, 2024; ETC CE, 2024, p. 40). The integration of a circular economy in waste management hence carries significant potential for mitigating climate change (EEA, 2024). Accelerating the transition to a circular economy necessitates an exhaustive picture of factors that advance and slow down or obstruct the process in waste management companies. The chosen micro level approach was deemed to provide valuable insights into the practical implementation of circular practices within companies, which is necessary in driving a systemic transition. The first research question is as follows:

> ***RQ1:*** *What are the primary driving and inhibiting factors impacting the transition towards circular economy in waste management?*

Expanding the focus from micro to meso level is essential as the emergence of an entire innovation ecosystem is researched and the focus is on a circular economy park. To thoroughly understand the emergence of innovation ecosystems, it is crucial to explore the underlying motivations driving actors' participation in such ecosystems, and therefore, identify the drivers of innovation ecosystem emergence. Simultaneously, recognising the factors that inhibit the emergence of an entire innovation ecosystem is requisite to fully understand the formation of these ecosystems. This is also highlighted by Rabelo Neto et al. (2024) who argue that the development process requires understanding the factors that impact the dynamics and performance of the ecosystem. Thus, the second research question is formulated as follows:

> ***RQ2:*** *What are the driving factors that advance the emergence of an innovation ecosystem, and what are the factors inhibiting or obstructing it?*

A successful establishment and realisation of the full potential of circular economy parks require addressing barriers. By overcoming these barriers, the study provides insights into how coordinated efforts can facilitate the successful establishment and development of circular economy parks. Currently, studies focusing exclusively on circular economy

parks and the associated driving and inhibiting factors seem scarce and expose a notable research gap. A successful development of the circular economy park depends on the presence of the factors impacting the transition to a circular economy and innovation ecosystem emergence, which are essentially considered as fundamental prerequisites. Without them, achieving positive and desired outcomes is challenging. As there is limited research exploring the interplay and synergies of circular economy transition and innovation ecosystem emergence, the intersection remains unresearched. The third research question is:

> ***RQ3:*** *How are the identified factors that impact the circular economy and innovation ecosystems interconnected?*

Addressing these research questions enriches the understanding of the development of circular economy parks, and thereby, contributes to a more comprehensive picture. Besides, the study provides a pragmatic view as called for in both circular economy and innovation ecosystem research (Dedehayir, Mäkinen & Roland Ortt, 2018; De Jesus & Mendonça, 2018; Jacobides, Cennamo & Gawer, 2018). The multidisciplinary approach addressing inter-organisational collaboration is a valuable lens in fostering innovation ecosystems and advancing circular economy practices, creating new and insightful perspectives.

This study is conducted as a part of the KARHU project, *Circular Economy Value Creation and Tomorrow's Capabilities in the Satakunta Technology Metal Cluster*, at Tampere University, which aims to foster interactive value creation, accelerate circular economy Research, Development & Innovation (RDI) and initiate new research projects, while concurrently understanding the future university education skills and needs of the technology metal cluster. The project adhered to an action research strategy, which is an emergent and iterative process that aims to solve real organisational issues using a collaborative and participative approach (Reason, 2006; Coghlan, 2011; Coghlan & Shani, 2018). Typically, in action research, interventions or actions are implemented into the research context by the researchers in response to identified issues that are then followed by observing the impact of these actions (Bhattacherjee, 2012, p. 40). The researchers served as facilitators during the research process (Greenwood & Levin, 2007), actively contributing to its progress.

The framework of this study combines the research of innovation ecosystems and circular economy in the form of a circular economy park. In this framework, inter-organisational collaboration is recognised to be the linking force between these two concepts: circular economy necessitates inter-organisational collaboration (Bocken et al., 2016;

Ghisellini, Cialani & Ulgiati, 2016; Konietzko, 2021) whereas innovation ecosystems enable it (Moore, 1993). That is, transitioning to a circular economy happens through inter-organisational collaboration within innovation ecosystems, and without inter-organisational collaboration neither can be successful. Together circular economy and innovation ecosystems can drive the systemic change towards a more sustainable society. This study's framework is presented in figure 1.

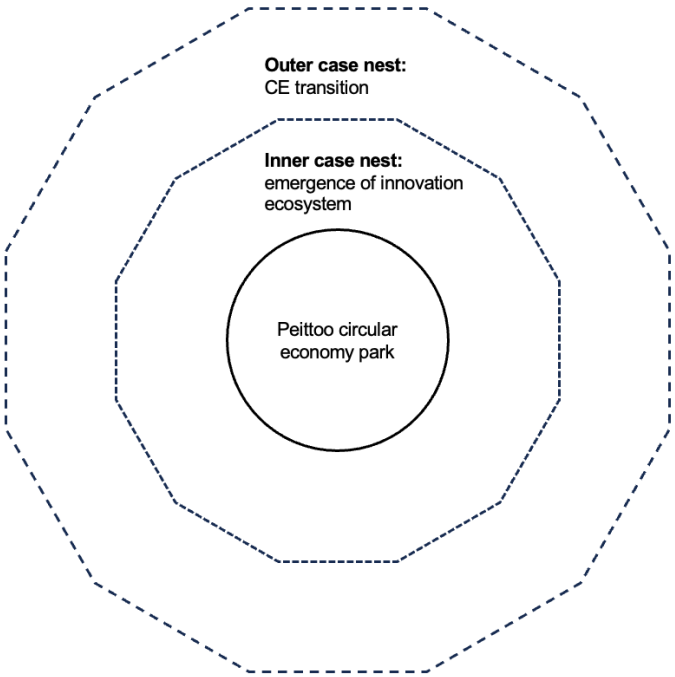


***Figure 1.*** *Theoretical framework of the study adapted from Grünbaum (2007).*

The framework of this study is built upon the framework created by Grünbaum (2007), who divided case studies to consist of inner and outer case nests. In this study's framework, the development of a circular economy park consists of two essential concepts, emergence of an innovation ecosystem and circular economy transition. This can be divided into an inner case nest, describing the internal dynamics of the circular economy park, and outer case nest, primarily focusing on the external dynamics. This emphasises the holistic consideration of factors impacting these two processes, which both need to be addressed in order to achieve an operational circular economy park. As mentioned before, the term of circular economy park is absent in academic literature. In this study, a circular economy park is defined as follows:

> A circular economy park is a specialised zone for a wide range of circular economy activities where co-located businesses innovate and collaborate to share resources, materials, and information, and where one company's waste becomes another's resource.

## 1.3 Structure of the Study

The study comprises six chapters, including introduction, two theoretical chapters, research methodology, an empirical chapter where the results of the study are presented, and lastly, a conclusion. The first chapter introduces the background and significance of the study, including a brief overview of circular economy and innovation ecosystems. The research objective, questions, and scope that shape and guide the research process as well as the framework of the study are delineated.

Chapters 2 and 3 provide a theoretical foundation for the study. The first theory chapter delves deeper into the concept of a circular economy. Sub-chapter 2.1 focuses on the conceptualisation of the circular economy and sub-chapter 2.2 discusses the role of circular economy in industrial waste management. In sub-chapter 2.3, circular economy transition drivers and barriers are outlined based on previous literature. The second theory chapter discusses innovation ecosystems. Sub-chapter 3.1 covers innovation ecosystem definitions as well as innovation ecosystem roles and characteristics. The emergence and development of innovation ecosystems is reviewed in sub-chapter 3.2.

After the theoretical background, the research methodology of the study is presented. In sub-chapter 4.1, the research design is broadly discussed, and the methodological choices are justified. Thereafter, the case selection process and technique are elucidated in sub-chapter 4.2 which is followed by the sub-chapter 4.3 where data collection is thoroughly deliberated, comprising both primary and secondary data. In sub-chapter 4.4, the data analysis is described providing a holistic overview of the process. Lastly, sub-chapter 4.5 evaluates the validity and reliability of the methodology.

The findings of the study are presented in chapter 5. Sub-chapter 5.1 includes an introduction to the selected case, focusing on the boundaries of the ecosystem and the current state of the circular economy park. Sub-chapter 5.2 covers the identified factors impacting the circular economy in waste management companies, which is followed by sub-chapter 5.3 that presents the recognised factors driving the innovation ecosystem emergence. Sub-chapter 5.4 presents the innovation ecosystem emergence barriers, and the summarising sub-chapter 5.5 consolidates all the drivers and barriers identified in both concepts. Concluding this section, sub-chapter 5.6 explores the synergies between the CE and innovation ecosystems.

Finally, chapter 6 summarises the key findings of the study (6.1) and presents its practical implications (6.2). In the subsequent sub-chapter 6.3, quality and limitations of the study are discussed, which is then followed by the sub-chapter 6.4, in which future research avenues are provided. The study is concluded with references and appendices.

# 2. TRANSITION TO CIRCULAR ECONOMY

This chapter provides a theoretical basis for circular economy. First, the concept of circular economy and its definitions are discussed, laying the groundwork by providing a comprehensive outlook on the topic. Subsequently, the role of circular economy in industrial waste management is explored. Lastly, the drivers and barriers of circular economy transition are presented and a categorisation for them is provided.

## 2.1 The Circular Economy Concept

The circular economy is introduced as a more sustainable alternative for the current linear economy (Ghisellini, Cialani & Ulgiati, 2016; Singh & Ordoñez, 2016; Ranta et al., 2018) by simultaneously aligning the aspirations of economic growth and environmental conservation (Lieder & Rashid, 2016) and has received widespread attention from academia, policymakers, and business practitioners (Geissdoerfer et al., 2017). Regardless of the increased interest in the circular economy, the concept is interpreted differently by individuals and many definitions are concurrently in use (e.g., Kirchherr, Reike & Hekkert, 2017; Crocker et al., 2018). However, the most recognised definition of the CE is by Ellen MacArthur Foundation (2013, p. 7) that defines it as

> *"an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and within this, business models."*

Based on the extensive literature review Geissdoerfer et al. (2017) conducted, they further define the CE as

> *"a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling."*

Unlike the traditional linear economy, the circular economy aims to close loops, so that ideally no waste is generated (Zink & Geyer, 2017; Salminen, Heikkinen & Kujala, 2023, p. 430). The transition to a circular economy requires a systemic change (Heikkinen, Kujala & Blomberg, 2023, p. 3) involving all actors in the society (Ghisellini, Cialani &

Ulgiati, 2016). It requires efforts and actions from all levels of society, covering micro, meso and macro levels (Kirchherr, Reike & Hekkert, 2017; Blomberg, Kujala & Heikkinen, 2023, p. 136; Heikkinen, Kujala & Blomberg, 2023, p. 3). The circular economy is founded upon three principles, aimed at eliminating waste and pollution, circulating products and materials, and regenerating nature (Ellen MacArthur Foundation, 2020). In this manner, the CE alters the way products and services are produced, consumed, and disposed. Although the circular economy is often lauded for its potential in operationalising sustainable development (environmental, economic, and social sustainability), the relationship between them is weak (Kirchherr, Reike & Hekkert, 2017; Millar, McLaughlin & Börger, 2019; Velenturf & Purnell, 2021). Geissdoerfer et al. (2017) suggest that scholars mostly emphasise environmental sustainability over the other two dimensions, economic and social sustainability, lacking a holistic view on sustainable development. In direct contradiction to this, Ghisellini et al. (2016) and Kirchherr et al. (2017) argue that environmental and social dimensions of sustainability are overlooked due to the prevailing emphasis on economic considerations.

To ensure the environmental sustainability of the circular economy, systems thinking is required to prevent simply shifting emissions from one part of the system to another, while also avoid unintended environmental impacts (Velenturf & Purnell, 2021). For instance, the production of biofuel has reduced the dependencies on fossil fuels, but has accelerated deforestation (Murray, Skene & Haynes, 2017; Velenturf & Purnell, 2021). Additionally, the technology needed for a circular economy often relies on mining rare virgin raw materials (Murray, Skene & Haynes, 2017), which leads to adverse environmental impacts. Essentially, utilising recycled materials could amplify a product's overall environmental footprint if the recycling process itself has a high environmental impact (Gusmerotti et al., 2019). Zink and Greyer (2017) studied the unintended effects of the circular economy, namely circular economy rebound, arguing that circular economy activities may lead to an increase in overall production, diminishing its potential. Similarly, Korhonen et al. (2018) state that the improved secondary production efficiency reduces production costs, which will eventually result in the prices of end-products decreasing, boosting up consumption. To achieve reduced environmental impacts, less production and consumption are hence needed (Zink & Geyer, 2017). As the circular economy is intended to be restorative, the aim is to repair the caused damage by redesigning entire systems within industries (Murray, Skene & Haynes, 2017; Salminen, Heikkinen & Kujala, 2023, p. 432).

A successful transition to the circular economy can be accomplished by implementing a framework structured around three key strategies: narrowing, slowing and closing resource loops (López Ruiz, Roca Ramón & Gassó Domingo, 2020). The aim of closing resource loops is to create a circular flow of resources through recycling. Slowing resource loops is about extending the lifespan of products and materials through, for instance, repair, refurbishment, and remanufacturing. Narrowing resource loops focuses on the reduction of resource use and streamlining production processes, and thereby, minimises the need to extract new resources and materials. (Bocken et al., 2016; López Ruiz, Roca Ramón & Gassó Domingo, 2020.)

In the circular economy, there are various approaches, so called R-strategies or R-imperatives that have been designed to curb resource and material consumption, fostering the transition to a circular economy (Potting et al., 2017, p. 14). The framework of 3Rs; 'Reduce, Reuse, and Recycle', is the most used framework (Schulz, Hjaltadóttir & Hild, 2019), which has been modified and extended by some authors, ranging from 3Rs to 10Rs (Reike, Vermeulen & Witjes, 2018) as the concept has evolved over time. The 4R framework adds 'Recover' to 3Rs (Kirchherr, Reike & Hekkert, 2017) while Reike et al. (2018) propose 10Rs that are built upon the insights of previous literature. There are some variations in the existing 10R-strategies. For instance, Potting et al.'s (2017) framework includes 'Rethink' (R1) instead of 'Remine', which Reike et al. (2018) added to their framework (Morseletto, 2020). Aside from that, these two frameworks have indistinguishable strategies. The overview of the 10R framework is provided in table 1.

***Table 1.*** *10R framework adapted from Reike et al. (2018).*

| Strategy | | | Description |
|---|---|---|---|
| **Short loops** | R0 | Refuse | Prevent the use of products or virgin raw materials |
| | R1 | Reduce | Using fewer virgin raw materials, eliminating waste generation |
| | R2 | Reuse | Using the same material or product again for the same function |
| | R3 | Repair | Repairing or maintaining the product to extend its lifecycle |
| **Medium long loops** | R4 | Refurbish | Restoring an old product |
| | R5 | Remanufacture | Manufacturing new products with discarded products or components |
| | R6 | Repurpose | Using discarded products or components to a new purpose |
| **Long loops** | R7 | Recycle | Processing waste or materials into new products or materials |
| | R8 | Recover | Incineration of materials with energy recovery |
| | R9 | Remine | Acquiring valuable components from disposed products |

The first four strategies, R0-R3, are regarded as the most preferable R-strategies in a circular economy (Reike, Vermeulen & Witjes, 2018) and characterised by a higher level of circularity (Potting et al., 2017) compared to medium long and long loops. A high level of circularity means that materials remain in circle for longer, and once discarded, they re-enter the supply chain ideally maintaining the original quality and value (Potting et al., 2017). Medium long loops are the strategies that are applied if short loops cannot be put into place. Medium long loops involve upgrading existing products (Reike, Vermeulen & Witjes, 2018) to extend their lifecycle. Lastly, the long loops are the least desirable options and typically considered as a part of the traditional waste management system (Reike, Vermeulen & Witjes, 2018). Morseletto (2020) adds to this stating that recycling (R7) and recovery (R8) may not always promote a circular economy because they reduce products' integrity and does not necessarily mean that products remain in the economy. Waste management systems are cornerstones in efficiently enabling the 10R-strategies (Ranjbari et al., 2021).

## 2.2 Circular Economy in Industrial Waste Management

In transitioning to the circular economy, the implementation of an effective waste management system is vital (Di Foggia & Beccarello, 2021) to better manage resources and minimise waste generation (Zeller et al., 2019; Ranjbari et al., 2021) by extending and closing material loops (Zeller et al., 2019). Waste management covers all the activities and procedures involved in handling waste throughout its life cycle, from inception to final disposal, through collection, transport, and treatment (Ranjbari et al., 2021). In the context of a circular economy, waste management efforts have primarily been given to recycling rather than waste prevention (Salmenperä et al., 2021). This is reflected in the increasing amount of waste being treated and recycled, but this alongside the decreased amount of waste being landfilled, has not affected the total amount of waste generated in Europe (Kujanpää & Pihkola, 2023, p. 165). López Ruiz et al. (2020) state that waste prevention offers a valuable opportunity to minimise waste generation and should be integrated in the planning phase of the design through the whole value chain, requiring engineers, architects and companies to develop communicative relationships. At present, businesses tend to overlook the product lifecycle as they only focus on manufacturing a product after which someone else is responsible for its discard (Jaeger & Upadhyay, 2020).

Industrial waste, which encompasses a wide range of hazardous and non-hazardous materials generated during industrial processes and operations, poses significant environmental concerns (C.-K. Yang et al., 2023). Heavy industries, such as construction

and demolition, have a significant circular economy potential (Wu et al., 2019). In the construction and demolition industry, certain materials are reused, such as concrete and brick, which are commonly crushed to create a recycled aggregate that can, for instance, be used for road construction (Wu et al., 2019), there is, however, still underutilised potential (López Ruiz, Roca Ramón & Gassó Domingo, 2020). The ever-increasing amount and complexity of wastes create challenges for effective and responsible waste management (Brunner & Rechberger, 2015; Zhang et al., 2019). Compared to other sectors of society, heavy industries generate significantly more potentially reusable residual materials, making industrial companies critical in meeting the recycling targets set by various countries (Levänen, 2015). Due to the high volumes of materials, waste management plays a crucial role in processing industrial waste through the key principles of the circular economy (eliminating waste & pollution, circulating materials, and regenerating nature). Zhang et al. (2019) assert that waste management systems must be smarter to achieve a zero-waste circular economy. However, the problem is remarkably complex, involving diverse stakeholders, necessitating shifts in behaviours, and requiring a thorough reconsideration of current waste management systems (Zhang et al., 2019). Similarly, Salmenperä et al. (2021) highlight the importance of updating the current traditional waste management practices and particularly the underlying mindsets and traditions to enable the implementation of new concepts.

The waste hierarchy, as outlined by the European Waste Framework Directive (WFD) in 2008, establishes a hierarchical order for waste management strategies, beginning with prevention and progressing through preparation for reuse, recycling, recovery, and disposal (Pires & Martinho, 2019) where prevention is the most preferred strategy and disposal the last option (figure 2). The previously discussed R-strategies of circular economy are closely connected to the waste hierarchy, with the main distinction being the inclusion of disposal in the waste hierarchy while the circular economy framework does not allow disposal (Zhang et al., 2022). Kirchherr et al. (2017) noted that only a third of the circular economy definitions explicitly outline waste hierarchies which the authors consider as “subverted CE definitions”. In the Waste Framework Directive, the EU attempted to clarify the legal distinction between definitions of industrial waste and by-products (Levänen, 2015; Zorpas, 2020) to create a more standardised and unified vision. However, according to D’Adamo et al.’s (2022) research, the legislative problem of identifying the point at which a material shifts from waste and becomes a secondary raw material, persists in many EU member states.

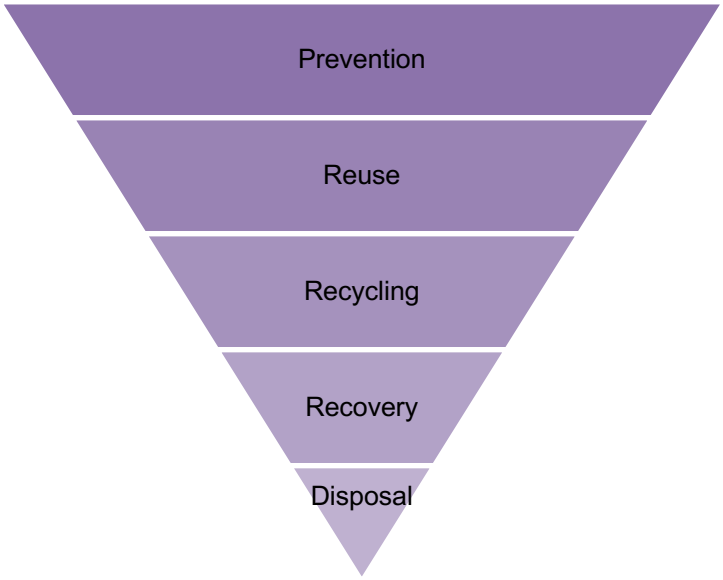


***Figure 2.*** *Waste hierarchy (European Commission, no date).*

Although the EU's waste framework directives emphasise the waste hierarchy, there are no indicators for implementing it (Pires & Martinho, 2019). However, the most widespread indicator is the recycling rate, which is criticised for overlooking other levels of the waste hierarchy, such as waste prevention and reuse, making it unsuitable for reporting the overall progress to the circular economy in waste sector (Pires & Martinho, 2019). Moreover, the recycling rate can represent waste management efforts when transitioning from the traditional final disposal to a recycling-based society but is not a suitable indicator for the transition from recycling to a circular economy (C.-K. Yang et al., 2023). Hence, recycling rates alone cannot reflect the implementation of waste hierarchy and its effectiveness. The primary focus of waste management should be on waste prevention yet measuring it is difficult (Zorpas & Lasaridi, 2013). Zhang et al. (2022) criticise the waste hierarchy for the main focus being on recovery and not addressing the relevance of other key factors, such as design and resource efficiency.

At the governmental level worldwide, the significance of the circular economy has been acknowledged. In 2020, the new circular economy action plan was adopted by the EU (D'Adamo et al., 2022), following the initial action plan that was proposed in 2015 (Sarja, Onkila & Mäkelä, 2021). The action plan seeks to promote a more sustainable use of natural resources, simultaneously fostering sustainable growth and job creation (C.-K. Yang et al., 2023), and has resulted in diverse circular strategies implemented in EU member states (Schulz, Hjaltadóttir & Hild, 2019). The transition to a circular economy requires the support of governments (Hartley et al., 2023), with environmental policies playing a crucial role in driving eco-innovation that aim to minimise waste generation and reduce material use (Cainelli, D'Amato & Mazzanti, 2020).

## 2.3 Circular Economy Transition Drivers and Barriers

Environmental challenges, including climate change, resource depletion, and biodiversity loss, resulting from unsustainable production and consumption (Lehtimäki et al., 2023, p. 1) drive the transition towards a circular economy (Tura et al., 2019). Despite these drivers, significant barriers to the adoption of the circular economy remain. Drivers are factors that facilitate the adoption of circular economy practices, whereas barriers are factors that hinder the transition, and thus, slow down the process or obstruct it completely. Some scholars have identified both drivers and barriers (e.g., De Jesus & Mendonça, 2018; Govindan & Hasanagic, 2018; Tura et al., 2019; Neves & Marques, 2022), while other authors have focused on barriers exclusively (e.g., Kirchherr et al., 2018; Grafström & Aasma, 2021; Salmenperä et al., 2021; Mishra, Singh & Govindan, 2022), and few authors have explored solely drivers (e.g., Gusmerotti et al., 2019). Existing literature on circular economy drivers and barriers in different contexts, such as supply chain (e.g., Govindan & Hasanagic, 2018), building sector (e.g., Giorgi et al., 2022), and mining industry (e.g., Upadhyay et al., 2021), some of which has identified and classified them into distinct categories. According to Tura et al. (2019), while no systematic categorisation of drivers and barriers had been put forward initially, they introduced a novel framework.

De Jesus and Mendonça (2018) studied drivers and barriers in the eco-innovation transition to circular economy and categorised them into soft and hard factors in which institutional/regulatory and social/cultural factors are soft and technical and economic/financial/market factors are hard factors. Tura et al. (2019) introduced a framework of drivers and barriers, and identified seven main categories that are environmental, economic, social, institutional, technological and informational, supply chain and organisational. In Tura et al.'s (2019) research, four case companies from different industries, namely energy, waste management and recycling, information and communications technology, and bio and forest, were represented. Salmenperä et al. (2021) identified circular economy barriers faced by developers and intermediaries in waste management. These barriers were categorised into economic and market-related barriers, technological and information-related barriers, institutional and regulatory barriers, and sociocultural barriers. Kirchherr et al. (2018) investigated the barriers to the circular economy in the EU, dividing them into cultural, market, regulatory, and technological barriers. In a similar manner, Grafström and Aasma (2021) explored the circular economy barriers from four distinct categories, technological, market, institutional, and social, not targeting any specific industry.

In this study, the framework is formed by integrating findings from a diverse range of articles (e.g., De Jesus & Mendonça, 2018; Tura et al., 2019; Salmenperä et al., 2021), to provide a comprehensive categorisation for circular economy transition drivers and barriers. Factors impacting the transition are categorised into (1) economic, (2) environmental, (3) institutional and regulatory, (4) sociocultural, and (5) technological and information-related factors. Generally, drivers and barriers arise from a combination of factors resulting from specific local conditions, rather than singular influences, and therefore, the categories are interconnected (De Jesus & Mendonça, 2018).

### 2.3.1 Economic Factors

Economic factors play a crucial role in a circular economy, as profitability is a primary objective for all profit-driven organisations (Govindan & Hasanagic, 2018). According to Gusmerotti et al. (2019), economic drivers are the most crucial ones in the transition within manufacturing companies. The potential to attain cost savings and increase profitability drives companies into adopting circular practices (Sarja, Onkila & Mäkelä, 2021). Similarly, minimising material costs and price volatility may encourage circular economy investments in organisations as the disposal of materials when they reach the end of their lifecycle is expensive (Hina et al., 2022). Through circular economy strategies, such as effective recycling and remanufacturing, businesses can boost their long-term revenue generation (Govindan & Hasanagic, 2018). The circular economy creates new business opportunities (Tura et al., 2019) as it reveals new ways to make use of resources (Sarja, Onkila & Mäkelä, 2021). Moreover, there is an urgent need to optimise resource utilisation, which incentives companies to develop new solutions (De Jesus & Mendonça, 2018) and create value from side streams and waste (Tura et al., 2019). The untapped potential in the field of circular economy allows companies to innovate and find more sustainable solutions, and possibly gain a competitive advantage.

The practical implementation of circular economy solutions is often hindered by economic and market-level constraints, such as high upfront expenses and market uncertainty (De Jesus & Mendonça, 2018). Particularly, small and medium enterprises (SMEs) frequently contend with resource limitations, complicating the adoption of circular economy practices (Mishra, Singh & Govindan, 2022). Low virgin material prices are frequently highlighted as a significant barrier to a circular economy (Kirchherr et al., 2018). Due to low virgin material prices, it may not be beneficial for companies to shift towards circular economy operations (Grafström & Aasma, 2021) as virgin raw materials are still cost-effective (Salmenperä et al., 2021). Singh and Ordoñez (2016) state that given the marginal difference in price between recovered materials and virgin raw materials, the

financial incentive to support material recovery is limited. According to Kirchherr et al. (2018), the root cause for low virgin raw material prices may stem from cultural barriers, which are discussed in greater detail in a later section. However, Hina et al. (2022) suggest that the lack of adequate policies gives rise to high prices of waste-based products and increased waste management costs.

It is essential to underscore that the market dynamics are influenced by the demand from producers, who utilise either virgin or recycled materials, and by the demand from consumers, who purchase the final products (Grafström & Aasma, 2021). Thus, Grafström and Aasma (2021) emphasise that establishing a functional circular economy necessitates the substitution of virgin raw materials with recycled materials, thereby requiring a higher demand for waste-based materials compared to virgin raw materials. Creating a consistent product from irregular waste streams is difficult as waste streams vary due to seasonal changes and location (Singh & Ordoñez, 2016). Additional costs regarding remanufacturing, such as administration and return transport costs, may offset the cost savings, resulting in higher overall costs compared to new production (Van Loon & Van Wassenhove, 2020).

### 2.3.2 Environmental Factors

Primarily, the need to shift from a linear to a circular economy arises from various environmental issues caused by the current linear economic system (Tura et al., 2019). The core driver is to mitigate negative environmental impacts, such as resource scarcity, environmental degradation, and an inefficient use of materials (Gusmerotti et al., 2019). A circular economy can significantly cut CO2 emissions (Kirchherr et al., 2018; Tura et al., 2019) by reducing the need for producing new products. Circular economy practices enable efficient material utilisation where valuable materials can be separated from waste and industrial by-products find useful applications (Tura et al., 2019). Moreover, promoting environmental safety and quality is an enabling factor for a circular economy (Hina et al., 2022).

The existing literature has not identified many environmental barriers regarding the circular economy, with one of few exceptions being the uncertainty surrounding the reuse of materials after reaching their end-of-life stage, which Hossain et al. (2020) identifies as a significant barrier in implementing the circular economy. Given that modern products comprise a combination of various substances, some of which may be hazardous (Kral, Kellner & Brunner, 2013), these harmful substances must be removed during the material handling process (Hossain et al., 2020) to prevent any environmental and health risks. In a similar vein, Bocken et al. (2017, p. 479) state that hazardous substances

within material cycles pose challenges to the circular economy as removing them is difficult.

### 2.3.3 Institutional and Regulatory Factors

Governments worldwide have implemented laws to promote circularity (Govindan & Hasanagic, 2018). A mix of policies and instruments is argued to be critical in enabling the circular economy (De Jesus & Mendonça, 2018; Wilts & O'Brien, 2019). Legislation is pivotal in guiding the decision between virgin raw and secondary materials by driving the market demand towards circularity (Giorgi et al., 2022). Bans for landfilling and increased demand for business transparency require businesses to implement circular practices (Tura et al., 2019). Moreover, other political elements, such as taxation and supporting funds, are important incentives to drive the transition (Hina et al., 2022). Kirchherr et al. (2018) emphasise the need for policies that advocate circular products, potentially giving a crucial boost to the circular economy.

Institutional and regulatory factors are often viewed as facilitating factors for circular economy, but they also represent major barriers (De Jesus & Mendonça, 2018). Regulations shape the economic landscape of industries, and Sarja et al. (2021) observed some regulations favouring the linear model which may be visible in taxes and material prices. In the research of García-Quevedo, Jové-Llopis and Martínez-Ros (2020), regulatory factors are identified as the main barriers, including "the cost of complying with regulations" and "the existence of complex administrative and legal procedures". According to Grafström and Aasma (2021), the most significant institutional barrier is the inconsistency of policies between countries. Similarly, Tura et al. (2019) argue that region-specific laws and regulations hinder the circular economy development. For instance, in Kirchherr et al.'s (2018) research, it emerged that transporting certain materials internationally for recycling purposes is not allowed. This may result in the material being disposed of in a landfill rather than being recycled overseas.

Currently, recycling is the most emphasised and institutionally supported circular economy approach, largely overlooking the reduce and reuse approaches which poses a significant barrier to transition (Ranta et al., 2018; Giorgi et al., 2022). In a similar manner, Hossain et al. (2020) highlighted that resource policies mainly prioritise the efficient use of resources rather than focusing on reducing resource demand. Govindan and Hasanagic (2018) suggest that the waste management laws in force do not support the circular economy as some environmental laws do not align with the principles of a circular economy. Environmental policies impact the definition of what is considered waste, and oftentimes, categorising materials as waste happens too quickly impeding the potential

for circulating the material or components of it (De Jesus & Mendonça, 2018). According to Hina et al. (2022), the EU's waste legislation does not provide clear distinction between waste material and by-products, which imposes limitations on cross-border waste transfers.

### 2.3.4 Sociocultural Factors

Sociocultural factors encompass the behaviours and attitudes of customers and organisations, both of which play a critical role in the transition to a circular economy. The circular economy requires societal acceptance, and as previously highlighted, engagement of all actors (Sarja, Onkila & Mäkelä, 2021). Regardless of the importance of sociocultural factors, De Jesus & Mendonça (2018) report that merely 20% of the academic literature addressing barriers in the circular economy includes this category, making it the least frequently mentioned. Similarly, the category was only raised in 21% of studies on circular economy drivers, positioning it as the second least mentioned category after technical drivers (De Jesus & Mendonça, 2018). However, in contrast, Kirchherr et al.'s (2018) research indicates that three out of five most pressing barriers were sociocultural factors, namely 'lacking consumer interest and awareness', 'hesitant company culture' and 'operating in a linear system'.

Another significant sociocultural barrier to a circular economy, specifically reuse, is recognised to be the preference of customers for new products which may be explained by the perception that sustainability entails a trade-off between price and performance (Ranta et al., 2018). Furthermore, customers tend to question the quality and safety of refurbished products, influencing the willingness to buy these products (Govindan & Hasanagic, 2018). As a result, manufacturers may be discouraged from pursuing refurbishment or remanufacturing practices (Govindan & Hasanagic, 2018). According to Salmenperä et al. (2021), customers' responses to waste utilisation in products differs and predicting consumer behaviour is challenging. Moreover, the limited interest of customers to invest in new technologies that support the circular economy is a prevailing barrier (Tura et al., 2019). One of the most critical transition barriers in construction and demolition waste management according to research conducted by Mahpour (2018), is the inadequate awareness and understanding of circular economy, requiring decision-makers to understand the concept and its benefits better.

Customers' increased awareness and demand for sustainability are key sociocultural drivers for the circular economy (Tura et al., 2019). As an external driver from customers, it pushes companies to implement sustainable measures to meet customer needs and demand. This driver is also identified by Govindan and Hasanagic (2018) who express

that consumers are more aware of the environmental impact of industries, thereby driving companies to pursue circular solutions. Leadership along with employees' mindset, knowhow and commitment are significant sociocultural drivers that determine circular economy implementation success (Hina et al., 2022) internally at the company level. Sarja et al. (2021) recognise the importance of individuals in enabling the change within companies but argues that the circular economy transition necessitates the support of top management. The environmental attitudes and motivations of the top management significantly influence a company's environmental proactivity (Gusmerotti et al., 2019).

### 2.3.5 Technological and Information-Related Factors

The adoption of relevant technology is a fundamental requirement for the transition to a circular economy (Kirchherr et al., 2018). Technological aspects are recognised as having both facilitating and impeding impacts on the circular economy transition (Sarja, Onkila & Mäkelä, 2021). A wide range of available technologies enables the collection, analysis and utilisation of data (Tura et al., 2019), allowing companies to innovate and develop their businesses as well as optimise their processes, reduce waste, and enhance resource efficiency. Selecting the most suitable technology requires a lot of knowledge of available options. If chosen correctly, modern technologies can notably enhance product design, extend product lifespan, and assist with monitoring operations (Sarja, Onkila & Mäkelä, 2021). In the building sector, material passports provide detailed information about the materials and products present in a building and identified as a promising solution for facilitating reuse and recovery (Giorgi et al., 2022). The use of material passports would offer traceability throughout the product life cycle together with information on quality and safety of used materials. Jaeger and Upadhyay (2020) emphasise the importance of product information to identify the most suitable approach on processing the product components. Additionally, material passports can form a foundation for a materials database, enhancing material stream management, which would be particularly useful in monitoring large material flows (Giorgi et al., 2022).

Although the rapid development of technology is an important driver to a circular economy, it also acts as a significant barrier due to the challenge of obsolescence, as newer technological solutions replace their older counterparts (Tura et al., 2019). Likewise, Van Loon and Van Wassenhove (2020) highlighted the rapid pace of technological progress as a challenge in the transition as innovation renders obsolescence, limiting the product recirculation. In De Jesus & Mendonça's (2018) research, technological factors were discovered to be a key barrier to the circular economy transition, including the availability

of appropriate technology, technology gaps, and the lack of adequately trained or specialised personnel. Conversely, technology did not emerge as a core barrier to the circular economy in the studies of Kirchherr et al. (2018) and Salmenperä et al. (2021). However, information-related factors were considered more critical for the transition, especially a lack of data assessing the benefits of circularity is a significant barrier (Salmenperä et al., 2021). In connection with this, Tura et al. (2019) came across similar results highlighting the absence of practices and systems for gathering, sharing, and utilising circular economy information, hinders the transition to a circular economy. The lack of regional waste data and thorough assessment of circular progress in Finland may impede identifying the most effective policy instruments (Salmenperä et al., 2021).

Another significant technological barrier discovered by Giorgi et al. (2022) is that the current technologies are not designed for disassembly, making it difficult to disassemble elements without causing damage. Jaeger and Upadhyay (2020) contribute to this finding by arguing that due to the complexity of products the disassembly process is complicated, expensive, and slow. The adoption of circular materials is limited by technological shortcomings related to tracking waste-based materials, ensuring the quality of them, and managing the uncertainty of second and subsequent cycles (Govindan & Hasanagic, 2018; Hossain et al., 2020). In Zhang et al.'s (2019) study of circular economy barriers in smart waste management in China, the potential of technologies is recognised, but several barriers regarding their effective use, such as incompatible technologies, were also identified. The lower homogeneity of materials and increasing complexity of products thereof require increasingly complex technical solutions for handling the material flows, creating a significant barrier for the recovery and reuse (Govindan & Hasanagic, 2018; Tura et al., 2019). The technology-intensive nature of circular practices, such as recycling, necessitate rigorous testing to ensure waste-based materials meet customer specifications, which poses another barrier to implementing circular economy (Jaeger & Upadhyay, 2020).

# 3. UNCOVERING INNOVATION ECOSYSTEMS

The second theory chapter delves into the concept of innovation ecosystems. First, a definition of an innovation ecosystem is discussed which is followed by an examination of the roles and characteristics of innovation ecosystems. Subsequently, emergence and development of innovation ecosystems is reviewed.

## 3.1 Definition of Innovation Ecosystems

The ecosystem concept was initially modelled after biology and introduced into the business context by Moore (1993) who suggested that companies should be perceived as part of a business ecosystem that extends across various industries rather than being a member of a single industry. Thereafter, the concept of ecosystems has gained increasing interest in industries and academia (Oh et al., 2016; Aarikka-Stenroos & Ritala, 2017; Ritala & Almpanopoulou, 2017; Jacobides, Cennamo & Gawer, 2018; Song, Gnyawali & Qian, 2024), and conceptualisations of a variety of ecosystems have emerged, such as innovation ecosystems, knowledge ecosystems, and industrial ecosystems (Aarikka-Stenroos & Ritala, 2017; Thomas & Autio, 2020). As the concept of innovation ecosystems has been widely adopted in different contexts, coupled with an inconsistent use and unclear definition, its usage has become ambiguous (Oh et al., 2016; Ritala & Almpanopoulou, 2017; Thomas & Autio, 2020). Furthermore, Oh et al. (2016) criticised innovation ecosystems, asserting they lack scholarly rigour. The critique received by innovation ecosystems has led to attempts to harmonise existing definitions and forge a cohesive definition (e.g., Granstrand & Holgersson, 2020). Adner (2017, pp. 40–42) makes a distinction between two perspectives, namely ecosystem-as-affiliation, which views ecosystems as communities of interconnected actors distinguished by their networks and platform affiliations, and ecosystem-as-structure in which ecosystems are perceived as arrangements of activities characterised by a value proposition. Autio and Thomas (2014, p. 205) define an innovation ecosystem as

> *"a network of interconnected organizations, organized around a focal firm or a platform, and incorporating both production and use side participants, and focusing on the development of new value through innovation."*

According to (Adner, 2017, p. 41), this definition falls under the ecosystem-as-affiliation view. The actor-centric ecosystem-as-affiliation perspective places emphasis on the actors and relationships between organisations interconnected with or revolving around a

focal company or platform (Autio & Thomas, 2014, p. 205; Adner, 2017, p. 41). Hou and Shi (2021) point out that ecosystem-as-affiliation studies tend to focus on the focal actor's network position and number of partners, overlooking the specifics of value creation, as criticised by Adner (2017).

The conceptual review Granstrand and Holgersson (2020) undertook, they found that the most widely recognised definition of innovation ecosystems is by Adner (2006, p. 98) who describe them as

> *"the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution."*

Another highly cited and widely used definition is put forward by Adner (2017, pp. 41–42) who suggested an alternative conceptualisation for ecosystems-as-affiliation, namely ecosystems-as-structure in which an ecosystem is an

> *"alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize."*

The ecosystem-as-structure, also identified as the activity-centric perspective (Dedehayir, Mäkinen & Ortt, 2022), originates from a value proposition and aims to identify the actors required to actualise the value proposition (Adner, 2017, p. 41). This view emphasises the structure of interdependent activities and how they contribute to value creation. Hou and Shi's (2021) analysis suggests that the ecosystem-as-structure versus ecosystem-as-affiliation should be replaced with the ecosystem-as-structure versus ecosystem-as-coevolution framing as the affiliation is integrated in both perspectives, although it tends to carry a narrower significance in the structure view than in the coevolution view. The ecosystem-as-affiliation seems to neglect the dynamic and interactive nature of ecosystems, whereas the ecosystem-as-coevolution focuses on how actors interact with each other and evolve over time. The ecosystem-as-coevolution is still in its infancy but is gaining traction in academia.

According to Granstrand and Holgersson (2020), the existing definitions of innovation ecosystems consist of three entities: actors, artifacts, and institutions. Through examining the definitions of innovation ecosystems, they identified essential components regarding activities and relations, which particularly emphasise collaborative and competitive dynamics, and the coevolving nature of innovation ecosystems. None of the existing definitions include all these components concisely and consistently, and therefore, Granstrand and Holgersson (2020) propose a new definition for innovation ecosystems:

> *"An innovation ecosystem is the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors."*

The core purpose of innovation ecosystems is to collaboratively create value that a single company could not achieve independently (Adner, 2006, p. 100). Through ecosystem activities, companies can provide complex solutions while maintaining the focus on their core business (Williamson & De Meyer, 2012). Hannah and Eisenhardt (2018, p. 1) emphasise that balancing competition and cooperation (i.e., coopetition) is crucial in achieving a successful ecosystem, as excessive cooperation may undermine value capture while excessive competition may hinder the ecosystem emergence. Each innovation ecosystem exhibits distinct characteristics that develop as a response to the region's cultural surroundings (Rabelo Neto et al., 2024). These distinctive elements shape ecosystem's functions, including how ecosystem actors collaborate, share resources, and overcome challenges.

### 3.1.1 Ecosystem Roles

Innovation ecosystems consist of heterogeneous and interdependent actors who collaboratively generate ecosystem-level outcomes (Thomas & Autio, 2020; Autio & Thomas, 2022). As innovation ecosystems comprise a diverse set of actors, various roles are involved. Authors outline several roles within ecosystems, each providing distinct viewpoints and terminology. According to Autio and Thomas (2014), the boundaries of ecosystems are difficult to define due to the open nature of ecosystems. This can pose challenges in determining which actors are considered being part of the ecosystem. Other scholars (Adner, 2017, p. 43; Oskam, Bossink & De Man, 2021) claim the actors contributing to the value proposition define the boundaries of ecosystems.

The roles of actors may evolve and change over the course of the ecosystem's development (Dedehayir, Mäkinen & Roland Ortt, 2018; Pushpananthan & Elmquist, 2022). According to Han et al. (2022), there are contradictory conclusions regarding whether ecosystem governance requires focal actors to orchestrate it. Harima et al. (2024) highlight the role of dominant actors, so called anchor firms or ecosystem leaders, which are important in catalysing the emergence of an ecosystem. In the early evolutionary stages of ecosystems, the ecosystem leadership involves creating a shared and aligned value proposition and understanding the benefits and challenges of achieving it (Foss, Schmidt & Teece, 2023). However, some ecosystems emerge through self-organisation (Williamson & De Meyer, 2012, p. 25; Thomas & Ritala, 2022). Pushpananthan and

Elmquist (2022) conclude that innovation ecosystems typically require a keystone firm or ecosystem leader to coordinate roles and activities for all actors within the ecosystem.

Adner and Kapoor (2010, p. 309) and Autio and Thomas (2022) identify innovation ecosystem actors consisting of a focal firm, complementors, suppliers, and customers. Expanding on this, Gomes et al. (2018) extend the scope to include the focal firm, customers, suppliers, complementary innovators, and regulators. Within the ecosystem, suppliers provide essential components or services, while customers create the demand in the market (Moore, 1996; Dedehayir, Mäkinen & Roland Ortt, 2018), influencing the innovation and shaping the ecosystem's trajectory. In fact, a new set of benefits for customers is of paramount importance, without which the costs of an innovation ecosystem cannot be justified (Moore, 1996). Complementors are actors that offer complementary products and services (Dedehayir, Mäkinen & Roland Ortt, 2018), whom Adner and Kapoor (2010) differentiate from suppliers by describing them as upstream actors in terms of the ecosystem and complementors as downstream actors (Gomes et al., 2018).

Dedehayir et al. (2018) identified multiple roles related to the innovation ecosystem emergence, including eleven roles that are grouped into four categories. These categories are leadership roles (ecosystem leader and dominator), value creation roles (supplier, assembler, complementor, and user), value creation support roles (expert and champion), and entrepreneurial ecosystem roles (entrepreneur, sponsor, and regulator). According to Dedehayir et al.'s (2018) study, the ecosystem leader is necessary for the ecosystem genesis for several reasons, including forming partnerships, distributing the value, and managing the platform. The direct value creation roles involve jointly delivering, assembling, and utilising key components and complementarities. The value creation roles are supported by value creation support roles provided by the 'expert', who creates and shares fundamental knowledge, and the 'champion', who specialises in establishing connections between actors to facilitate the emergence of the ecosystem. Entrepreneurial ecosystem roles encompass fostering and supporting the establishment of entrepreneurial ventures that drive the development of the innovation ecosystem. (Dedehayir, Mäkinen & Roland Ortt, 2018.)

### 3.1.2 Characteristics of Innovation Ecosystems

Innovation ecosystems have characteristics that distinguish them from other ecosystem types (see e.g., Thomas & Autio, 2020), such as business ecosystems, although sometimes these concepts are used synonymously (Gomes et al., 2018). Ritala et al. (2013, p. 248) differentiate innovation ecosystems from business ecosystems through the emphasis on innovation activities wherein value is created and captured. In contrast, some

other scholars suggest the differentiating factor lies in business ecosystems focusing on value co-capture and actor competition while innovation ecosystems emphasise actor collaboration and value co-creation (e.g., Gomes et al., 2018; Han et al., 2022). Nonetheless, Granstrand and Holgersson (2020) highlight that initially Moore (1993) gave equal attention to collaboration and competition in the definition of business ecosystems and add that the shift from business ecosystems to innovation ecosystems may have excessively emphasised collaboration over competition.

Han et al. (2022) investigated key features of innovation ecosystems and divided them into three dimensions – roles, structures, and processes. The findings of their research revealed nine key features, each of them categorised into these dimensions. The 'roles' dimension includes three key features, self-organisation, non-linearity, and shared vision. The second dimension called 'structures' includes complementarity, modularity, and coupling. The last dimension, 'processes' comprises emergence, coopetition, and coevolution. While various definitions by different scholars highlight specific characteristics of innovation ecosystems, none fully encompass all these features. However, these key features identified by Han et al. (2022) comprise the findings of previous literature, providing clarity on the characteristics of innovation ecosystems.

Innovation ecosystems are systemic, dynamic, and complex by nature (Han et al., 2022). As the forces shaping the structure of innovation ecosystems evolve over time, ecosystems rarely remain stable (Holgersson et al., 2022, p. 6) and continuously respond to the changes in the business environment. Thus, one of the core characteristics of innovation ecosystems is the ecosystem's ability to adapt and evolve (Autio & Thomas, 2014, p. 6). Furthermore, as mentioned earlier, innovation ecosystems are comprised of interconnected and interdependent actors working towards shared goals, the systemic nature is pivotal. A success of an innovation ecosystem is impacted by all actors of the ecosystem, not single participants (Adner & Kapoor, 2010), thereby understanding the contributions of all participants and dynamics within an ecosystem is essential. The complexity aspect is shaped by various factors, including the interactions of diverse actors (Han et al., 2022), interdependencies among components (Hannah & Eisenhardt, 2018; Jacobides, Cennamo & Gawer, 2018), and the delicate balance between the dynamics of cooperation and competition (Hannah & Eisenhardt, 2018). Adner (2017) discusses the multilateral nature of ecosystems, emphasising the intricate and interconnected relationships which cannot be understood by simply observing bilateral interactions.

According to Nambisan and Baron (2013), the three defining characteristics of innovation ecosystems are the dependencies between the ecosystem participants (actor interdependency), shared goals and objectives, and shared capabilities (complementarity).

Jacobides et al. (2018) makes a distinction between generic and specific complementarities, excluding generic complementarities from their definition of ecosystem because they believe the generic ones fail to motivate actors to collaborate and act collaboratively. Thomas and Autio (2020) identify four ecosystem characteristics, including participant heterogeneity, ecosystem outputs, participant interdependency, and ecosystem governance. Ecosystems chiefly exhibit heterogeneity because the ecosystem participants represent various actors from different industries and sectors (Thomas & Autio, 2020; Thomas & Ritala, 2022). Innovation ecosystems create system-level outputs (Autio, 2022), which go beyond the contributions and actions of any individual actor (Thomas & Autio, 2020). Ecosystems are characterised by non-contractual governance (Thomas & Autio, 2020) and coordination, which does not require hierarchical governance (Jacobides, Cennamo & Gawer, 2018). Holgersson et al. (2022) state that value creation and value capture within ecosystems create a unique coordination challenge where co-operation and competition should be balanced to unlock the full potential.

## 3.2 Emergence and Development of Innovation Ecosystems

Only a small number of studies have focused on the innovation ecosystem emergence process (Dattée, Alexy & Autio, 2018; Thomas & Autio, 2020), particularly in terms of empirical investigations (Pushpananthan & Elmquist, 2022; Thomas, Autio & Gann, 2022). The process of innovation ecosystem emergence is characterised by complexity as ecosystems are built around interdependent actors (Almpanopoulou, Ritala & Blomqvist, 2019). Foss et al. (2023) underscore that a successful ecosystem emergence necessitates the involvement of participants that make ecosystem-specific investments and adhere to shared rules. Walrave et al. (2018) emphasise that ‘external viability’, shaped by the broader socio-technical context, is critical in determining the success of an ecosystem, which the literature has often neglected. The prevailing socio-technical environment tends to resist change (Walrave et al., 2018), in which innovation ecosystems may struggle to operate. Moore (1993) introduced evolutionary stages of ecosystems, including birth, expansion, leadership, and self-renewal or death, which describe the lifecycle of ecosystems. Other scholars (e.g., Dedehayir & Seppänen, 2015; Dedehayir, Mäkinen & Roland Ortt, 2018) have also adopted the emergence stages of Moore (1993).

In the birth phase, the focus is on defining the customers’ product and service requirements and discovering the value proposition (Moore, 1993; Dedehayir & Seppänen, 2015). The ecosystem birth is generally described to be more iterative and chaotic than the subsequent phases of the emergence (Dedehayir, Mäkinen & Roland Ortt, 2018) as

actors try to form a shared vision through balancing cooperation and competition (Han et al., 2022). Dedehayir and Seppänen (2015) suggest that the birth phase can be broken down into two separate sub-phases, invention and start-up. The invention sub-phase is distinguished by its focus on inventing, developing, and testing the new technology whereas in the startup sub-phase the technology is operationalised in practical settings, both of which prepare the ecosystem for the expansion phase (Dedehayir & Seppänen, 2015).

During the expansion phase, the ecosystem expands into new territories (Moore, 1993; Dedehayir & Seppänen, 2015). The ecosystem grows rapidly as the number of participants, and thereby, interactions within the ecosystem increase, which consequently leads to higher levels of complexities (Han et al., 2022; Thomas, Autio & Gann, 2022). Throughout the expansion stage, value discovery activities become less frequent as both ecosystem and individual-level value propositions stabilise (Thomas, Autio & Gann, 2022). Han et al. (2022) highlight that the shared vision undergoes slight adjustments and refinements but remains relatively focused.

The third stage of ecosystem emergence is leadership wherein the aim is to move towards stability in the processes and structures of the ecosystem (Moore, 1996; Dedehayir, Mäkinen & Roland Ortt, 2018), while simultaneously determining the leadership of the ecosystem (Dedehayir & Seppänen, 2015; Dedehayir, Mäkinen & Roland Ortt, 2018). Moore (1993) emphasises that the ecosystem's growth and profitability must be compelling enough to be worth contending for. To remain competitive, the ecosystem leader must actively guide the future direction and investments of key customers and suppliers within the ecosystem (Moore, 1996). Essentially, the leader's ability to think beyond short-term gains emphasises the need for long-term vision, which is critical for the success of the entire ecosystem.

Lastly, the final stage is self-renewal or death of the ecosystem. The renewal, or alternatively death, of the ecosystem is a response to events of a wider environment of the ecosystem (Almpanopoulou, Ritala & Blomqvist, 2019), such as new emerging ecosystems and innovations or new governmental regulations (Moore, 1993, p. 81; Dedehayir & Seppänen, 2015; Dedehayir, Mäkinen & Roland Ortt, 2018). To maintain a long-term success of an ecosystem and ability to renew itself, innovations hold a vital role (Moore, 1993, p. 84). Dedehayir et al. (2018) emphasise the role of ecosystem leaders in catalysing innovations and facilitating a fundamental restructure to avoid the ecosystem death.

Thomas et al. (2022) investigated emergence processes of platform ecosystems and introduced a three-stage model of ecosystem emergence, consisting of launch, expansion, and established. This model differs primarily from the previously mentioned four-stage evolutionary model with the emphasis on internal dynamics and development of the ecosystem, whereas Moore's (1993) approach focuses more on market dynamics. During the launch stage, the orchestrator collects resources and together with early participants discusses and creates a value proposition (Thomas, Autio & Gann, 2022). In a similar manner, Han et al. (2022) identify three developmental stages of an ecosystem – birth, expansion, and maturity stage. When an innovation ecosystem reaches the maturity stage, it achieves an optimal level of complexity and dynamics (Han et al., 2022). With these few differences, the emergence stages defined by Thomas et al. (2022) and Han et al. (2022) align with Moore's (1993) birth, expansion, and leadership phases.

Ecosystems necessitate intentional and thorough planning of activities as they do not merely spontaneously emerge (De Silva, Howells & Meyer, 2018; Jacobides, Cennamo & Gawer, 2018). In Pushpananthan and Elmquist's (2022) study, it was found that the development of new technology can lead to the emergence of an innovation ecosystem, and three triggers for this emergence were identified. The first trigger that instigated the emergence was the need for resources and competence, the second trigger was the interdependence between actors, and the need to synchronise their activities, and lastly, the third trigger was the need to orchestrate and manage the network's balance. The findings from Dattée et al. (2018) research suggest that ecosystem emergence entails greater uncertainty, reciprocal commitment, and continuous adaptation than described in previous scholarly works. Coordination and cooperation problems impede the establishment of ecosystems, which necessitates effective ecosystem leadership (Foss, Schmidt & Teece, 2023). During the initial stages, emerging ecosystems frequently encounter difficulties in acquiring resources and institutional support, which leads to high failure rates (Thomas & Ritala, 2022). Over time, the emergence of an ecosystem undergoes a shift from discovery, resourcing, and commitment to forming connections and trust, and finally culminating in value creation (Dedehayir, Mäkinen & Roland Ortt, 2018). That is to say, the ecosystem encounters multiple shifts during its emergence, bringing new opportunities and challenges. Williamson and De Meyer (2012) suggest that ecosystems may flexibly evolve as new ecosystem actors join and existing ones leave the ecosystem. Ecosystem actors voluntarily join an innovation ecosystem, often driven by the opportunity to provide innovative inputs (Autio, 2022).

# 4. RESEARCH METHODOLOGY

In this chapter, the research methodology employed in the study to address the research questions and objectives is thoroughly explained. Sub-chapter 4.1 discusses the research design of the study, covering all the research design choices. Sub-chapter 4.2 depicts the case selection process, including case selection criteria, criteria for selecting the units of analysis, and a brief overview of the case. The focus of sub-chapter 4.3 is on data collection methods and sources. Sub-chapter 4.4 provides an overview of the data analysis process and strategies utilised. Finally, in sub-chapter 4.5 the validity and reliability of the chosen methodology is assessed.

## 4.1 Research Design

Research strategies are not mutually exclusive, allowing different strategies to be utilised together (Saunders, Lewis & Thornhill, 2019, p. 190). A research strategy is a comprehensive plan on how the research is conducted and in which the researcher applies to answer their research questions (Johannesson & Perjons, 2014, pp. 39–40). This study employs a research strategy of a case study which investigates a real-life phenomenon providing in-depth understanding and insights of the matter (Yin, 2009, p. 18), yet it incorporates elements from action research due to the KARHU project's utilisation of action research principles. As the objective of this study is to find solutions on how to build an innovation ecosystem to improve both collaboration and circular economy as well as get a comprehensive understanding of the current situation, case study was considered appropriate to fulfil the research objectives. Pragmatism emphasises the importance of discovering solutions to practical problems and applies an outlook that goes beyond the scope of academia (Wills & Lake, 2020, p. 5). To support the selected research strategy, pragmatism was a logical option for the research philosophy as the study aims to solve the previously mentioned real-world business problem.

As aforementioned, innovation ecosystems have received a growing interest and have been a popular research topic in academia especially since the turn of the century (Gu et al., 2021), but in the context of circular economy there are still uncovered research streams and potential. Saunders et al. (2019, p. 157) propose it would be appropriate to work abductively when there is ample information of the topic in one context but significantly fewer in the context that is studied. Therefore, the most suitable research approach was abduction. Abductive approach moves between theory and empirical data

and as such combines deduction and induction (Suddaby, 2006, p. 639). In abduction, data are collected for exploring a phenomenon and identifying themes and patterns for the purpose of generating a new theory or modifying an existing one that is eventually tested through additional data acquisition (Saunders, Lewis & Thornhill, 2019, p. 153). The primary object of abduction is to discover new insights and explanations (Kennedy, 2018), and in such a way allows the researcher to focus on practical solutions (Wills & Lake, 2020, p. 29). Thus, abductive approach aligns with case study emphasising the pragmatic viewpoint and in-depth exploration. It is worth noting that the interview questions used in this study were not directly designed for this research, rather they were part of a broader KARHU research project, allowing themes to emerge from the data set and empirical data to shape the study.

The purpose of the research design is typically divided into three types: exploratory, descriptive, or explanatory (Hesse-Biber & Leavy, 2011, p. 10), or may even be a combination of some sort (Saunders, Lewis & Thornhill, 2019, p. 186). In this study, the exploratory purpose is employed, to begin with investigating the emergence of the innovation ecosystem, and the descriptive purpose is comprised to identify the inhibiting and driving forces of the ecosystem and the challenges actors face. Combining these two research purposes was regarded as the most fitting alternative as exploratory purpose seeks to discover and understand an under-investigated topic and descriptive aims to expand knowledge and provide detailed information of the topic (Hesse-Biber & Leavy, 2011, p. 10). Both exploratory and descriptive purposes coalesce seamlessly with the research questions of the study.

A single case study, more precisely an embedded case study is conducted to collect qualitative data. An embedded case study examines several units of analysis within the single case (Su, 2018). In this study, the focus is on a single case that is situated in a broader ecosystem context that consists of multiple actors where the ecosystem is perceived as a whole, thus entailing the inter-organisational aspect. Focus on a single case supports the objective of gaining a comprehensive view of the problem and ecosystem. The time horizon of the study defines the timeframe in which the study will be undertaken. In a cross-sectional study, the study is conducted at a particular time rather than over an extended period (Sachdeva, 2009, p. 11). A cross-sectional time horizon is applied in this study as the current state of the ecosystem and how it could be developed is researched rather than examining change and development over a longer period of time. Thus, the data were collected over a short period which, however, included multiple observations which is commonly regarded as an element of a longitudinal study (Patil &

Patil, 2020, p. 70). Figure 3 illustrates all methodological choices that were adopted in the study.

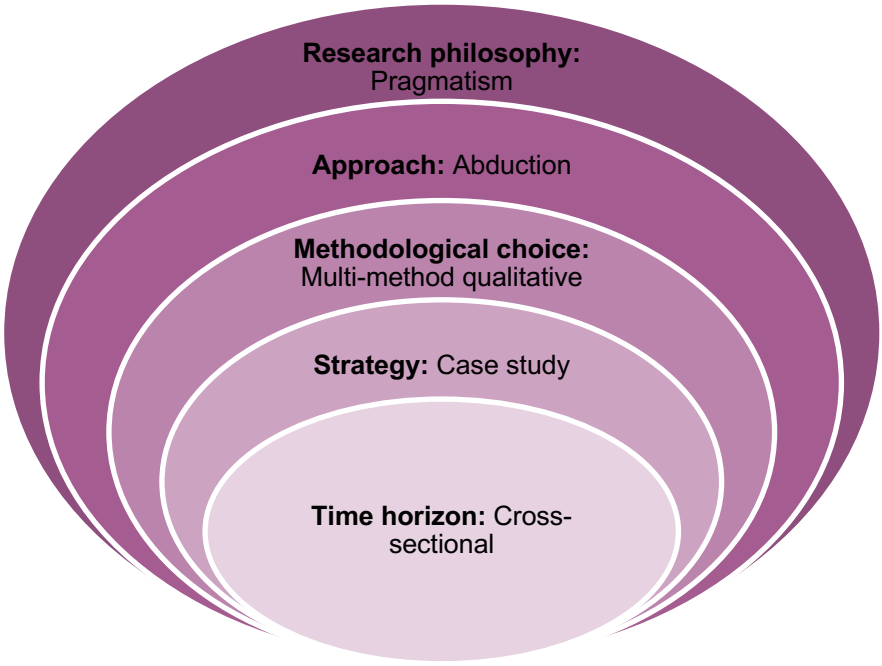


***Figure 3.*** *Research design choices (adapted from Saunders et al. (2019)).*

## 4.2 Case Selection

The sampling technique employed in the study was purposive sampling, also recognised as non-probability sampling or judgemental sampling (Kothari, 2004, p. 59). In purposive sampling, the researcher purposively selects the sample units instead of relying on random sampling (Patil & Patil, 2020, p. 77). Purposive sampling aims to select informative cases to gather in-depth data in order to address research questions (Schreier, 2018; Patton, 2023). Therefore, purposive sampling is viewed as viable for providing rich information about a specific case (Bickman & Rog, 2009, p. 79; Patton, 2023). At a more detailed level, the case selection process followed criterion sampling (Suri, 2011, p. 69). According to Patton (2002, p. 238), in criterion sampling the cases that adhere to the predetermined criteria are included in the study. The criteria for the case selection of this study can be grouped into two categories. The first criterion is the willingness to look for new ways to collaborate and enhance circular economy practices. As the study seeks to identify the drivers and barriers in the emergence process of innovation ecosystems, the second criterion is that the ecosystem approach is by some means present but not yet developed.

The case selected that aligns with the case selection criteria is Peittoo Circular Economy Park located on the western part of Finland in the city of Pori. As the research objective

is not only about discovering and understanding the factors that influence the emergence of innovation ecosystems, but also investigating how to overcome the barriers that companies face when forming an innovation ecosystem, Peittoo Circular Economy Park was considered an insightful case to study. Additionally, since the study focuses on the context of circular economy, it is essential that some circular economy practices are already in place. Peittoo Circular Economy Park focuses on processing industrial by-products and wastes, such as contaminated soil, scrap metal, and batteries (Pori & Prizztech, no date). There is scant documentation available and seems like no academic studies have been conducted before.

For the selection of actors within the case, the applied sampling strategy was purposive sampling, more specifically criterion sampling and snowball or chain sampling (Patton, 2002, pp. 237–238). Criterion sampling was predominantly used, but snowball sampling was utilised as a supplementary sampling strategy. In the context of the Circular Economy Park, the selection of companies was remarkably influenced by geographical boundaries, meaning that companies located in the area were included in the study. This is crucial as the ecosystem approach involves multiple actors and collaboration between them, so perspectives from different actors and roles are necessary to consider. As the focus is on waste management, the wind power plant that operates within the circular economy park was excluded from the study. In snowball sampling, the existing participants identify other potential participants that meet the selection criteria (Bhattacherjee, 2012, p. 70). In this study, participants recommended individuals that have broad expertise in the themes of the study and who are closely related to the area, for instance, through active collaboration with the actors of the Circular Economy Park. With snowball sampling it is possible to include actors that are less visible but still hold valuable perspectives or insights (Koerber & McMichael, 2008, p. 459). In this manner, actors that would have remained unnoticed were identified and participated in the study. The study incorporates sixteen units of analysis, which will be introduced in greater detail in the following sub-chapter.

## 4.3 Data Collection

In qualitative research, multiple sources of data are generally gathered, including but not limited to interviews, observations, and documents instead of utilising a singular data source (Creswell & Creswell, 2023, p. 171). Saunders et al. (2019, p. 179) posit that this is recognised as a multi-method qualitative study. In this study, the primary data were

mainly collected through semi-structured interviews, group discussions, and material interviewees provided. Table 2 provides an overview of the data sources gathered in the study.

***Table 2.*** *Summary of data sources.*

| Data type | Data source and volume of data |
|---|---|
| Primary data | 9 interviews<br>Group discussions |
| Secondary data | 13 webpages<br>3 reports<br>1 brochure<br>1 database |

Interviews are a flexible way to gather qualitative data during which the researcher can focus on emerging themes (Cassell, 2015). In this study, the interviews were aimed to explore the topic and get a comprehensive picture of the current situation. Interviews conducted individually with participants can contribute to a more comfortable and trusting atmosphere (Brinkmann, 2013, p. 27). Therefore, individual interviews were conducted to provide a private and confidential setting for open dialogue. Following the completion of the interviews, a goal review meeting was assembled with the research group and interviewees to review the identified themes and key topics based on the preliminary findings of the interviews. It aimed to ensure a shared understanding of the most pertinent issues that can be discussed and further examined during the group discussion. The group discussion, on the other hand, fostered interaction and encouraged to share perspectives with each other to collectively find solutions to the identified issues. Adams et al. (2014, p. 145) state that validation interviews are used to determine whether the collected data has been interpreted correctly. While traditional validation interviews were not employed in the study, some elements of them were embedded in the group discussions. These group discussions were used to validate the findings through a collaborative dialogue and additional questions that facilitators asked. Finally, a wrap-up and reflection session was organised to evaluate the impact of the research, gather feedback from participants, and offer participants an opportunity to provide additional information or clarify any misinterpretations. The research process is outlined below in figure 4.


***Figure 4.*** *Research timeline.*

The subsequent sub-chapters 4.3.1, 4.3.2 and 4.3.3 discuss and provide detailed information of each data collection method.

### 4.3.1 Interviews

As the emergence of an innovation ecosystem is an interactive and multilateral process that comprises many actors (Thomas, Autio & Gann, 2022), interviews were an adequate way to start the data collection. Interviews stand out as one of the most important methods for collecting data in qualitative research (Qu & Dumay, 2011), and oftentimes the most common source of data in both case study and action research (Eriksson & Kovalainen, 2008). They provide valuable opportunities for the researcher to understand and explore the research topic (Cassell, 2015) along with asking follow-up questions during the interview (Weathington, Cunningham & Pittenger, 2012, p. 187). Additionally, interviews are an effective method to acquire information when publication is not available (Eriksson & Kovalainen, 2008).

Before the interviews, themes and a list of key questions were designed. With a set of key questions, semi-structured interviews allow the researcher to compare the responses of each participant (Saunders, Lewis & Thornhill, 2019, p. 437) as well as guide the conversation to cover topics that the interviewers desire to acquire more information about (Qu & Dumay, 2011). As the interviewees consisted of both representatives of companies and authorities, the pre-determined questions were structured to match each role so that every perspective was represented. That is to say, the interview guides were shaped by the role of the participant resulting in different interview questions and emphases of each topic (appendix A). The interview themes for the waste management companies broadly covered various topics, including current material streams, opportunities of circular economy in waste management, and driving and inhibiting factors of co-innovation and collaboration within the ecosystem. For the other organisations, the interview questions were mostly formulated around environmental permits and circular economy. The key questions were shared with the participants, the aim being that they can familiarise themselves with the interview themes beforehand, potentially leading to more in-depth responses.

Generally, face-to-face interviews are perceived as the most suitable and valuable way to obtain qualitative data as the interviewer can observe subtle distinctions that emerge

in face-to-face contact (Cassell, 2015), such as the attitudes of the participants. In other words, it enables the interviewer to observe both non-verbal and verbal behaviour (Sachdeva, 2009, p. 168). Hence, the interviews were mainly organised in-person, but participants were given the right to choose an online interview if they preferred; five interviews were carried out face-to-face, and four were conducted online. This way participants could also attend the interview from a broader geographic area (Sachdeva, 2009, p. 168), and finding the most convenient time slots for the interviews was more efficient and flexible. According to Saunders et al. (2019, pp. 476, 478), this type of interview is referred to as a synchronous electronic interview where the interview is conducted in real time using technology, such as video conferencing platforms. The online interviews conducted in this study used both audio and video connections and took place in Microsoft Teams. Table 3 below presents the detailed data of the interviews.

***Table 3.*** *Interview data.*

| Interviewees | Date | Organisation | Title | Interview format | Interview duration |
|---|---|---|---|---|---|
| **I1** | 04/09/2023 | Waste management company | Business manager | Face-to-face | 89 min |
| **I2** | 05/09/2023 | Environmental permit authority | Senior environmental officer | Face-to-face | 98 min |
| **I3** | 05/09/2023 | Supervisory authority | Senior inspector | Face-to-face | 83 min |
| **I4** | 06/09/2023 | Waste management company | Site engineer | Online | 56 min |
| **I5** | 07/09/2023 | Waste management company | Facility manager | Face-to-face | 111 min |
| **I6** | 07/09/2023 | City | Project manager | Online | 54 min |
| **I7 & I8** | 08/09/2023 | Waste management company | Material centre manager (I7) & Operations manager (I8) | Face-to-face | 60 min |
| **I9** | 12/09/2023 | Waste management company | Production manager | Online | 83 min |
| **I10** | 11/10/2023 | Consultancy | Senior specialist | Online | 61 min |

As recommended by Saunders et al. (2019, p. 216), two other researchers were present in all the interviews because it was considered to improve the overall research quality. This enhanced the notetaking and enabled a more fruitful conversation with the interviewees through a broader range of clarifying questions. All the interviews were recorded

with the permissions of the interviewees and notes were taken. The recordings were transcribed by external transcribers for data analysis. Transcripts and recordings are vital components of the research process, especially for analysing the data (Leavy, 2014, p. 35). Recordings allow the researchers to re-listen to the interview and notice fascinating and subtle features about the interaction that would have otherwise been overlooked during the interview or afterwards forgotten (Rapley, 2018, p. 54).

### 4.3.2 Group Discussion

Based on the insights gained from interviews, a group discussion was arranged for the participants. All the interviewees were invited to the discussion, and additionally, experts from related fields were invited to participate in the group discussions to provide broader perspectives with theoretical and practical insights. From ten interviewed participants, six were able to participate (I1, I3, I4, I5, I7 & I10). Participants that exclusively involved in the group discussion go by the identifiers GD1, GD2, GD3, GD4, GD5 and GD6, are introduced in table 4. GD1 is affiliated with the same organisation as I4, but due to a busy schedule GD1 was not able to take part in the interview. In addition to these participants, six members of the research group were present, four of whom had the role of a facilitator, including myself. The group discussion was arranged on the 31st of October 2023 and lasted a total of four hours. The entire four-hour session was recorded.

***Table 4.*** *Group discussion data.*

| Participant | Organisation | Description |
|---|---|---|
| GD1 | Waste management company | Top management |
| GD2 | Private sector | Expertise in the fields of marketing and innovation ecosystems |
| GD3 | City | Represents the public sector |
| GD4 | City | Represents the public sector |
| GD5 | Tampere University | Researcher with specialisation in sustainable value creation |
| GD6 | University of Turku | Research on innovation activities |

The aim of the group discussion was to delve deeper into the identified issues, promote collaboration between the actors and find potential solutions. The group discussion was divided into three themes that researchers had suggested to the participants in the goal review meeting to ensure the suitability of the initial themes and that they are worth to focus on. These themes were (1) circular economy and profitability, (2) environmental permits, and (3) collaboration between the actors within the ecosystem, and each theme

was further separated into 2-3 sub-themes. A slideshow of the interviews' preliminary findings was presented as a supporting material to guide the course of the day. For each theme, a theme map was created that summarised the findings of the interviews and relations of these findings (see sub-chapter 4.4). These theme maps served as a foundational basis for the discussions.

Each discussion followed the me-we-us method (Nyström, Mustonen & Yrjölä, 2016). All the themes were covered one by one, and the conversations were divided into smaller predetermined discussion groups according to the sub-themes. First, everyone worked alone on their sub-theme (me-time), then participants worked on the topic with a small group (we-time), and last, all groups shared their ideas on the topic with everyone (us-time). The method was used to promote the discussion between different actors and collaboratively find solutions to the identified issues.

### 4.3.3 Secondary Data

Secondary data were gathered to improve the reliability and validity of the primary research data. Secondary data can be qualitative or quantitative (Saunders, Lewis & Thornhill, 2019, p. 341), and it encompasses a wide range of types, including written and non-written materials as well as survey data (Walliman, 2011, p. 79). In this study, the secondary data comprised of case reports, brochures, websites of government agencies (environmental administration, Finnish Tax Administration, etc.), and the European Union database, to validate the findings of the primary data. Secondary data sources were, furthermore, utilised to complement the primary data due to the potential to provide additional insights and mitigate the risk of misinformation. However, despite extensive efforts to collect secondary data, a substantial amount of relevant information was not readily available. As noted by Walliman (2011, p. 79) and Saunders et al. (2019, pp. 353–354), the purpose behind the collection of such secondary data may not meet the research questions or objectives of this study as the secondary data have been collected with a different purpose. In line with this, Adams et al. (2014, p. 105) highlight the importance of considering secondary data's validity within the context of the ongoing research. Thus, finding the most relevant secondary data is critical to ensure the usefulness and compatibility of the data.

## 4.4 Data Analysis

The data were analysed in multiple phases in a systematic manner. Typically, in qualitative data analysis, the data collection and data analysis phases proceed partly simulta-

neously unlike in quantitative research (Creswell & Creswell, 2023). Where data collection and analysis overlap, the researchers can adjust data collection to probe into themes that emerge in data analysis (Eisenhardt, 1989, p. 539; Bhattacherjee, 2012, p. 96). Consequently, the researcher can identify topics or themes where additional data, or clarification is needed.

Thematic analysis was the selected method for analysing primary data. The core purpose of thematic analysis is to identify and analyse the themes and patterns within the data set (Braun & Clarke, 2006, p. 79). Regardless of the employed research strategy and approach, thematic analysis is an applicable method for qualitative data analysis as it has developed as a separate method instead of being integrated into a methodological approach rooted in theory (Saunders, Lewis & Thornhill, 2019, pp. 651–652). Braun and Clarke (2006) break down the process into six phases: (1) familiarising oneself with data, (2) generating codes, (3) creating themes, (4) reviewing themes, (5) defining and naming themes, and (6) presenting the results. Even though the process can be described linearly with separate stages, it is remarkable that the analysis is not a linear process but moves back and forward between different stages (Braun & Clarke, 2006, p. 86; Saunders, Lewis & Thornhill, 2019, p. 652). These phases were applied in this study where applicable.

As indicated before, the main data sources consisted of interviews and group discussions, and the analysis of these two data sources was conducted slightly differently. The initial data analysis of the interviews was conducted by three researchers, including myself, and the second phase of the analysis, which encompassed the interviews and group discussions, was conducted by me. The initial data analysis started with familiarisation with data through reading notes that were written during the interviews, reading the transcriptions and re-listening to the recordings. The second phase included coding the data, meaning that codes were assigned to each key phrase, such as *environmental permits, collaboration opportunities and challenges, and circular economy*, and there was a total of 70 codes. The coding phase was conducted inductively, allowing the themes to emerge directly from the data (Saunders, Lewis & Thornhill, 2019, p. 652). At this stage, winnowing the data is crucial for managing the volume of the data and prioritising the most relevant and useful data while disregarding other parts (Guest, MacQueen & Namey, 2012, pp. 67–68; Creswell & Creswell, 2023, p. 181). After generating codes for each statement and winnowing the data, the initial phase of theming was conducted. The following two phases were strongly overlapping with each other. The themes were further defined and specified, and lastly, thematic maps were created to describe the main themes and relations between sub-themes. The initial data analysis of the interviews was

conducted before the group discussions were arranged, providing in-depth understanding of the topic, and allowing researchers to focus on the most insightful perspectives during the group discussions.

The analysis of group discussions began with taking down notes while listening to the recordings and reading post-it notes written by the participants during discussions. Key points and noteworthy quotes were hereby effectively captured. The themes brought up during the discussions were then added to the analysis of interviews and followed the same systematic procedure. At this stage, the second phase of data analysis was undertaken, comprising insights from the individual interviews and group discussions. The data analysis was an iterative process with continuous refinement and specification of the codes and themes. Therefore, the initial codes and themes from the first phase of the analysis were refined to better answer the research questions of this study. The themes consisted of circular economy drivers, circular economy barriers, innovation ecosystem drivers, innovation ecosystem barriers, and circularity within the ecosystem. Abductive approach was employed to categorise the sub-themes, which initially emerged from theory and were subsequently refined during data exploration (Saunders, Lewis & Thornhill, 2019, p. 652). Integrating the analyses of both individual and group contexts provided a holistic understanding of the research data.

The qualitative data analysis software ATLAS.ti 23 was used to carry out the data analysis. With the help of ATLAS.ti, the researcher can more easily manage and organise large amounts of data efficiently and analyse it systematically (Friese, 2012). Such a software can also streamline the process of restructuring and reorganising the coding scheme (Gibbs, 2014, p. 291), which can increase the accuracy and quality of the data analysis. In this study, ATLAS.ti was especially helpful in the initial phase of the data analysis as it was conducted by a team, enabling knowledge sharing and consistency throughout the process. Furthermore, it simplified assessing and redefining the codes and themes, particularly in the second phase of the analysis. After the documents were added to the software, the analysis proceeded as formerly described.

## 4.5 Validity and Reliability of the Methodology

Validity and reliability are used to evaluate the quality of the research methods employed in a study. Measurement validity assesses the appropriateness of used measures, internal validity refers to the accuracy of the analysis, and external validity assesses the generalisability of the findings (Saunders, Lewis & Thornhill, 2019, pp. 213–214). Reliability assesses the consistency (internal reliability) and replication (external reliability) of a study (Adams, Khan & Raeside, 2014, pp. 245–246; Saunders, Lewis & Thornhill, 2019,

p. 213). Essentially, reliability measures how consistently an instrument produces the same results when used in the same setting with the same subjects (Adams, Khan & Raeside, 2014, p. 245). Reducing errors and biases in a study is the objective of reliability (Yin, 2009, p. 49).

To increase the validity, several validation methods were applied. Triangulation is a validation method that refers to using multiple methods or data sources in research to enhance the accuracy of research data, analysis, and interpretation (Saunders, Lewis & Thornhill, 2019, p. 218). Data triangulation, the use of multiple data sources, and investigator triangulation, the use of several researchers (Patton, 2015, p. 316) were both used in this study. Data triangulation was employed by combining interviews, group discussions, and secondary data to increase the quality and reliability of the study. Saunders et al. (2019, p. 216) point out that internal reliability can be improved with the use of several interviewers as well as data analysts. Thus, several researchers were involved in conducting the interviews, and the initial data analysis was performed by a team of three researchers to minimise bias and gain a nuanced and correct interpretation.

Furthermore, Saunders et al. (2019, p. 218) brought up another validation method, namely participant validation, in which the research data is returned to the participants to check its accuracy. In this study, the goal review meeting was arranged to ensure that the objective of the intervention is correct. The goal review meeting was organised based on the findings of the interviews, which then served as a foundation for creating theme maps utilised during the group discussions on the intervention day. Finally, a report of the intervention's findings was shared with participants, inviting them to provide feedback and report any issues.

Validity and reliability were considered in data collection throughout the whole research process. Before conducting the interviews, the participants received the interview questions, allowing them to prepare and collect relevant information. Both interviews and group discussions were recorded, and notes were taken to reduce bias and improve the accuracy of data analysis. Additionally, the interviews were transcribed by external transcription services ensuring the accurate conversion of spoken content into written text and maintaining consistent formatting across all transcriptions.

The reliability of a study can be compromised by several threats, such as participant error, participant bias, researcher error, and researcher bias (Saunders, Lewis & Thornhill, 2019, p. 214). The earlier mentioned validation method, participant validation, was regarded to reduce participant error. Investigator triangulation had a positive impact on reliability as well, by decreasing researcher error and researcher bias. Furthermore,

the abductive approach significantly enhanced the reliability of the study by promoting iterative refinement of the identified themes, and as a result, led to a more comprehensive outlook.

# 5. RESULTS

This chapter presents the results of the study by following the research questions. Sub-chapter 5.1 gives a closer look to the actors and boundaries of the emerging innovation ecosystem, while further elucidating the rationale behind including specific actors in the study. Sub-chapter 5.2 answers the first research question, covering circular economy drivers and barriers in waste management. Sub-chapters 5.3 and 5.4 answer the second research question, in which the focus is on the driving and inhibiting factors of the emergence of the innovation ecosystem. Sub-chapter 5.5 brings together all the identified drivers and barriers impacting the two concepts, circular economy and innovation ecosystems. Lastly, sub-chapter 5.6 addresses the third research question, describing the interconnectedness between the circular economy and innovation ecosystems.

## 5.1 Actors and Boundaries of the Innovation Ecosystem: Peittoo Circular Economy Park

Peittoo circular economy park is an area designated for handling industrial, construction, and energy by-products and wastes (Business Pori, no date; Circular Economy Centre, no date; Pori & Prizztech, no date) in southwest of Finland, located 20 kilometres away from the city of Pori, currently offering over 700 hectares of zoned land for businesses (Business Pori, no date). The ongoing zoning process will provide about 133 hectares of new land (Pori & Prizztech, no date), including around 40-70 hectares for industrial and commercial blocks (I6). Currently, five waste management companies operate in the area, offering treatment, storage, and disposal of a wide range of waste (Circwaste, 2022; Business Pori, no date; Pori & Prizztech, no date), such as construction and demolition waste (concrete, asphalt, etc.), ash, and contaminated soil (I1, I4, I5, I7 & I9). The operators of Peittoo primarily serve customers from the construction, energy, forest, and mining industry (I1, I4, I5, I7 & I9). The aim of the circular economy park is to reduce waste through productisation and reuse of materials and create new business opportunities (Circwaste, 2022). Additionally, a wind farm is operating within the circular economy park, but it was excluded from the study as the focus is on waste management.

Regardless of the ambitious goals for the Peittoo circular economy park, the current operations are still mainly linear, and a diverse array of materials ends up in landfills. Oftentimes, the industry operator has already processed and utilised the materials before the actors of Peittoo receive them, making Peittoo the final destination (I5) which may

alter the opportunities for waste reuse. The actors use circulating material mainly in landfill construction (I1, I5 & I9), reducing the need for virgin raw materials. The companies have their own landfills, some of them being landfills for hazardous waste and some being landfills for non-hazardous waste, wherein the waste is landfilled. 80% of the Peittoo area is owned by the city of Pori (Pori & Prizztech, no date).

Based on the interviews and group discussions, it was found that there is not much collaboration between the companies and only occasional material batches, mainly soil materials, move between the companies. As of now, an innovation ecosystem has not yet been established. To understand the emergence, underlying inhibiting and driving factors are examined. The circular economy relies on collaboration, just as the emergence of an innovation ecosystem. To foster effective collaboration in the circular economy park, there is a pressing need for new companies that engage in circular economy practices (I1, I5, I6 & I7).

The industry is heavily shaped by laws and regulations (I1, I2, I5 & I9) as waste management companies are required to have an environmental permit. The companies' activities are centred around environmental permits, influencing the actions companies can take. For instance, productisation for external purposes (e.g. utilisation by another company) may be restricted or prohibited while internal utilisation within the company may be permitted depending on the granted permit.

*"The law regulates the work of ours [authorities], and the environmental permit is necessary for such an activity that causes the risk of pollution, and the legislation, the Environmental Protection Act, has precise lists of what type of activity requires the permit." (I2)*

The environmental permit application is submitted to either the Regional State Administrative Agency (AVI) or the municipal environmental protection authority, determined by the nature and scale of the activity (AVI, no date). The Regional State Administrative Agency approves larger, more extensive operations that burden the environment while the municipality grants smaller functions (I2). In this study, when referring to environmental permits, those granted by AVI are covered, not the municipality. Notably, all waste management companies engage external consultants for their environmental application processes as the process requires in-depth knowledge of the permit requirements and environmental laws. The Centres for Economic Development, Transport and the Environment (ELY centres) are responsible for reporting and monitoring the state of the environment (ELY, 2023) as well as assessing of permit change needs (I2) and act as a contact authority in environmental impact assessment (EIA) (ELY, 2023). ELY centres have other responsibilities, but the previously mentioned are the most relevant in the

context of this study. The environmental impact assessment serves as a project planning tool aiming to reduce and prevent negative environmental impacts (ELY, 2023; I3) and intended to be conducted prior to applying for an environmental permit (I3).

## 5.2 Adoption of Circular Economy Practices in Waste Management

The factors impacting the adoption of circular economy practices in the Peittoo circular economy park are divided into drivers, factors that drive the adoption, and barriers, factors inhibiting the adoption of circular economy practices. The drivers and barriers are categorised into five sub-categories following the categorisation established in the theoretical background. The sub-categories are (1) economic, (2) environmental, (3) institutional and regulatory, (4) sociocultural, and (5) technological and information-related. It is worth noting that not all drivers and barriers have an equal negative or positive impact. The factors were identified from a micro level perspective, specifically focusing on what drivers and barriers companies face as well as considering the insights from the public sector. Although these drivers and barriers were analysed at the micro level, they can occur at a different level. The findings are summarised in figure 5, which includes the most critical drivers and barriers, and subsequent sub-chapters provide a more detailed exploration of these factors.

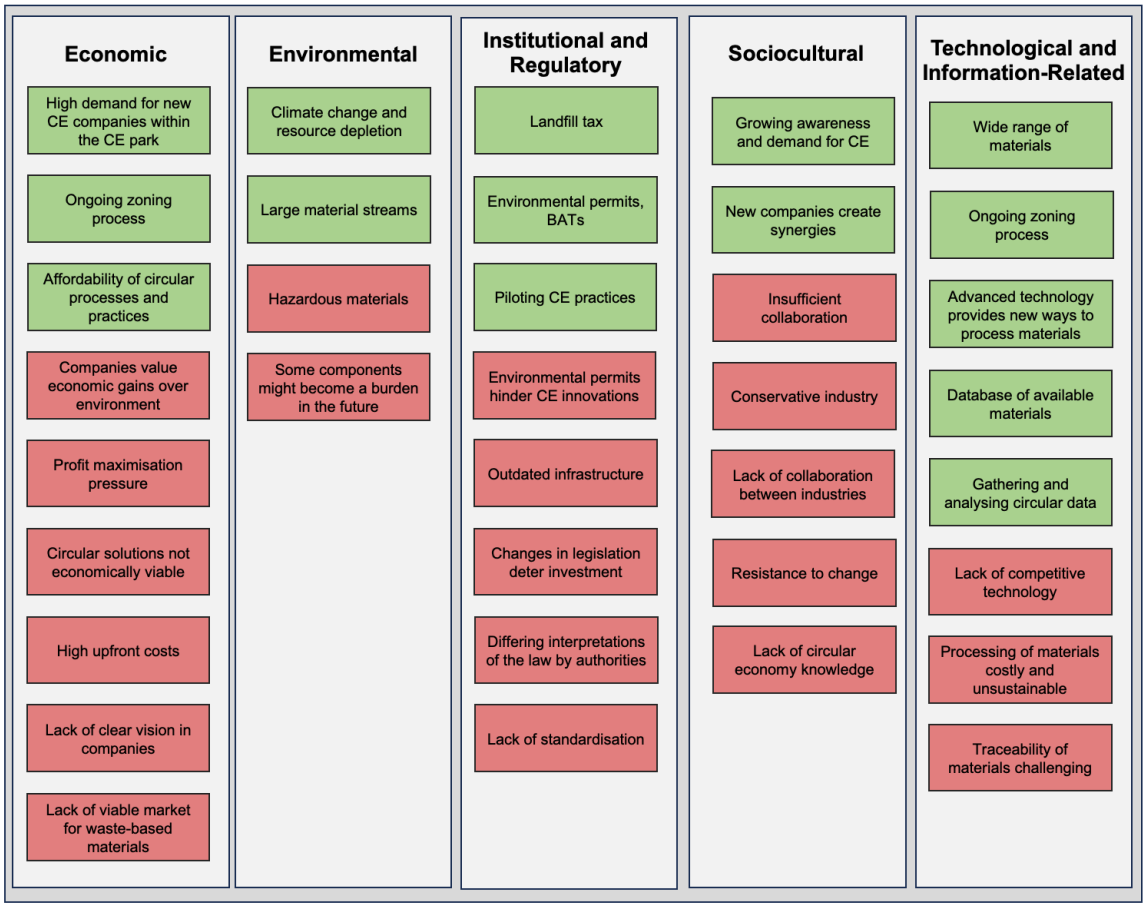


***Figure 5.*** *Drivers and barriers impacting the circular economy transition in Peittoo circular economy park.*

### 5.2.1 Drivers of the Circular Economy Transition

## Economic Drivers

Cost considerations are pivotal drivers in advancing the shift towards a circular economy. As companies evaluate the associated costs, they also assess the growth opportunities that the circular economy provides. In the long run, the ability to expand business operations is crucial. The cost-effectiveness of processes and practices directly impacts the flow of waste materials, and whether they are disposed of or reused. To encourage waste management companies to opt for environmentally sustainable solutions, it is essential that the costs associated with recycling, reusing, and repurposing waste remain affordable (I5 & I9).

*“The cost needs to be reasonable, in my opinion, so that the material finds the right final destination.” (I5)*

As noted earlier, there is a high demand for new circular economy companies within the circular economy park, which was identified as a driver. The ongoing zoning process

enables new opportunities for businesses, and therefore, may bring new circular economy actors to the area and create new business activities (I6, I8 & I9). As an integral part of the zoning process, the planning of industrial and commercial blocks contributes to enhancing new circular business opportunities. The role of the city is important in enhancing new business opportunities through measures like zoning as it holds 80% ownership of the lands in Peittoo:

*"Certainly, the first thing that comes to mind is zoning, which enables operations and expansions. Naturally, the city plays an important role." (I9)*

*"Of course, the more business activities are made possible in general, the better." (I7)*

## Environmental Drivers

Environmental crises, such as climate change and resource depletion compel waste management companies and other industrial operators to innovate towards more environmentally sustainable processes and shift their focus from the linear model to a circular one. The demand for a circular economy is greatly affected by depletion of natural resources, such as minerals, as well. Heavy industries like mining and construction are resource intensive, thus, there is a lot of potential for waste management companies to process and utilise these materials:

*"Still, if you think about the [waste] statistics by tonnage, it is still those waste masses from the mining industry that are the biggest. And there is a great potential for utilisation of stone materials." (I1)*

In Finland, mining and quarrying contributed to 75.1% of the total waste and 11.8% of the total waste was generated from construction and demolition in 2020. The same year in the EU, construction accounted for the highest waste generation with 37.5% of the total waste while mining and quarrying ranked second with 23.4%. (Eurostat, 2023b.) By reusing the waste generated in these industries and extracting resources from waste, the need for virgin raw materials can be reduced and resource efficiency promoted.

It was recognised that a circular economy exists in regions with large material streams (I1), so the volume of materials itself may work as a driver for circular economy. This means that large material streams can drive companies to pilot new ways to reuse, recycle, and repurpose materials. When waste management companies manage large-scale material streams, the materials can be harnessed more effectively as companies are more likely to implement recycling and remanufacturing processes. With fewer and smaller material batches it may not be worth investing in certain circular economy activities.

## Institutional and Regulatory Drivers

Waste management as an industry is seemingly changing slowly as it has traditionally followed linear approaches. Regulatory factors seem to be one of the most effective, if not the most effective, ways to shift waste management practices towards circularity. Changes in legislation can directly affect the economic factors of certain activities or industries, making circular economy more profitable, and in certain instances, mandatory:

*"Prior to the ban on organic waste landfills in Finland, if it had not come and only the waste tax had increased, most of it would still go directly to the landfills. So yes, money dictates a lot. And through that, what actually really guides and in a way forces forward, is legislation." (I9)*

Tightening sustainability regulations from the EU and at a national level drive the transition to a circular economy. These regulations demand companies to search for new circular economy solutions. The EU has set ambitious recycling targets for each member state. The recycling targets guide the transition to a circular economy by promoting sustainable waste management practices, such as reuse and recycling of materials, and cutting the amount of waste sent to landfills or incineration.

*"When thinking about the recycling targets, namely Finland's recycling targets, we will never get to them without considering the materials of this heavy industry, like the mining industry, because they generate substantial volumes of waste." (I1)*

At a national level, raising the landfill tax aims to incentivise companies to reduce the amount of landfilled waste and instead increase the utilisation of the waste, promoting circular practices. As from 2023, the waste tax on landfilled waste increased from €70 to €80 per tonne in Finland (Ministry of the Environment, no date a). This legislative factor creates economic pressure on companies to shift from a linear model to a circular one as landfilling may become more expensive than the reuse and repurpose of waste.

Waste, as defined by waste legislation, is considered taxable when there are technical and environmental justifications for its utilisation (Vero, 2024). The waste tax is regarded as one of the primary drivers for advancing the circular economy. Without the waste tax, utilisation of the material may not be financially feasible. However, the introduction of a waste tax is an effective way to redirect materials from landfills towards renewed purposes, discouraging activities that have more negative environmental impacts.

*"If a waste tax were applied to slag, it would immediately become worth utilising." (I1)*

In Finland, certain materials that were previously exempt from waste tax are now included under waste taxation due to recent changes in tax policies. As of 2023, waste

containing gypsum became subject to waste tax (Vero, 2022; Ministry of the Environment, no date a), and beginning in 2027, the tax base will be extended to include green liquor dregs (Ministry of the Environment, no date a).

*"There will be a waste tax on, for example, green liquor dregs, which then turns out to be directed to reuse with the help of that tax." (I5)*

All actors within the circular economy park are required to have an environmental permit as the operations may cause a risk of environmental pollution. Oftentimes, environmental permits require the permit holder to reduce their environmental impacts (AVI, no date; Ministry of the Environment, no date b), through limiting emissions, minimising waste generation, maximising resource efficiency, and adopting more sustainable technologies. Environmental permits can require using Best Available Techniques (BATs) that support the aspects of sustainability (I2 & I4) and promote circular economy solutions. In waste management, BATs refer to the available techniques that are most suitable for reducing or preventing the impact on the environment (Canova et al., 2018).

*"There are certain processes in the EU for preparing the best available techniques for different industrial sectors, which are then published and can be required to be followed in these [environmental] permits." (I2)*

The authority can make an initiative to change an environmental permit in certain situations. For example, if the BAT has developed to the extent that significant emission reductions can be achieved without incurring excessive expenses (AVI, no date), the permit holder is required to submit an application for changing the permit. By updating environmental permits, companies can be incentivised to adopt circular practices, such as reusing, recycling, and remanufacturing, and implement cleaner processes and technologies. Stricter permit requirements encourage waste management companies to minimise the amount of landfilled waste and reduce the use of virgin raw materials.

*"Our previous change to the [environmental] permit was largely related to these EU's BAT conclusions, and based on them, we were required to apply for a change to the permit." (I4)*

Applying for an environmental permit is a multi-phase process where authorities and other parties can send their opinions and objections regarding the application. However, not many environmental permit complaints are filed as the circular economy park is located far from settlements, thereby noise and dust are not typically an issue (I10). In such an area, environmental permits may be easier to acquire, which may lead to enhanced innovativeness and possibilities to invest in new circular economy practices.

When obtaining an environmental permit is easier, it creates a more favourable environment for companies to apply for permits, making the process feel less risky, ultimately encouraging companies to explore novel approaches. Additionally, experimentation and innovation are facilitated through providing the opportunity for the operators to pilot and test circular economy innovations (I1, I2, I3 & I5). Operators can engage in piloting and testing by submitting a notification of experimental activities (I2 & I3). Experimental activities are short-term, and can, for instance, be related to the use of waste as a raw material, new manufacturing and waste treatment methods (suomi.fi, 2024). This way operators may experiment with new materials and processes and assess the long-term effectiveness after which they can consider applying for an environmental permit. By initially experimenting, companies reduce the perceived risk in the environmental permit process, as they gain valuable insights into the performance of the new activities.

Green transition projects are increasingly promoted and financially supported by several institutions, such as the ELY Centre and Business Finland providing funding for green transition projects (I3). Green transition projects are also supported by AVI who issued a priority processing of environmental permits for green transition initiatives (ELY, 2024). In order to receive the priority processing and funding, green transition projects must adhere to the 'do no significant harm' (DNSH) principle (I3). This means that projects must not adversely affect climate change mitigation efforts, hinder the transition to a circular economy, or compromise biodiversity actions (ELY, 2024).

## Sociocultural Drivers

All five companies rely heavily on external material streams; hence, broader sociocultural dynamics influence their operations. As the circular economy gains attention, discussion surrounding its use increases, which itself advances the development of circular economy. The growing awareness of sustainability calls for companies to become more sustainable and promote circular economy practices, increasing the external demand for sustainability practices. One of the key drivers is the growing demand for circular economy practices internationally and nationwide. This has led to companies recognising the importance of a circular economy, and the willingness of companies to embrace environmental sustainability.

*"I can see that there is a lot of hype in the circular economy industry, and it is talked about a lot. I remember when I started in this [industry], they were talking about landfills mostly in this field. And now that [circular economy] is in." (I9)*

As discussed in the theoretical background section, the circular economy requires a systemic change, meaning that it is a collective outcome of a range of actors, such as businesses, policymakers, and customers. All interviewees recognised the necessity for new companies in Peittoo to enhance existing circular economy practices and develop novel ones. The underlying reason likely involves fostering synergies among companies – synergies that cannot be utilised or do not currently exist with the current companies. The full potential of circular economy can only be achieved in collaboration by aligning the circular efforts of organisations.

*"Other circular economy companies are definitely needed here. And in a way, through our actions [we could create] new business [opportunities] for them, and vice versa." (I1)*

## Technological and Information-Related Drivers

Technology can accelerate the development and innovation of the circular economy, providing new ways to process and utilise material streams and waste. There is a wide range of materials that can be utilised, but oftentimes they require unique processing methods employing material-specific technology (I5, I7 & I9). The modern technology enables the utilisation of materials that could not be reused before:

*"… today's technology makes several things possible, if you just think about the ash we have, we can get metals out of that ash as well." (I7)*

Another significant driver is reducing the dependency on virgin raw materials by finding a replacing material (I1, I5 & I9). Technological advancements have made it possible to substitute virgin raw materials with high-quality waste-based alternatives. For instance, using separation technology, harmful components can be separated from materials, ensuring their safety for reuse.

*"But part of the circular economy is finding another route; replacing virgin raw product [with other materials]." (I5)*

Simultaneously, technology provides ways to gather and analyse data, which is needed to fully understand the impact of used materials and processes on the environment, and the potential of the circular economy. At the moment, data on materials is only collected for monitoring purposes, namely annual reporting to the ELY centre, but is not utilised for other purposes. During the group discussion and some of the interviews, an idea of a local database or databank of available materials was brought up. This kind of databank was identified to have a lot of potential in driving the circular economy as other companies would be able to see the available materials that could be utilised, keeping the materials in circulation, and extending their lifespan. A nationwide website, called

Materiaalitori, is a marketplace for organisations to exchange, sell, and purchase materials, by-products, and residues, aiming to promote the reuse of materials and reduce the consumption of virgin raw materials (Motiva & Ministry of the Environment, no date; I2). Materiaalitori was not mentioned during the group discussion or during the interviews by any of the waste management companies, perhaps due to limited awareness of the platform's existence or that it is not widely used.

*"Maybe there could be a place for such a discussion, that something like Peittoo's soil or circular economy material bank could be just… I would say it would be a very good topic for a discussion." (I10)*

*"… if you were to think about this circular economy data bank, we do not really know what those, there is not any such database or data bank where you could see, okay, there is now a concrete block of that size that can be used, for example, in the foundation of road construction." (I6)*

### 5.2.2 Barriers to the Circular Economy Transition

## Economic Barriers

Economic factors were identified one of the most pertinent barriers to circular economy as companies tend to value economy over environmental matters. For instance, the profit maximisation pressure guides some companies to transport their waste where it can be obtained at the most affordable price without considering the sustainability aspect. Customers typically engage with waste management companies by paying them for waste treatment. Many customers prioritise cost over other factors when selecting a waste management company, often overlooking the company's waste management practices, and neglecting whether the waste is reused or disposed of.

*"The [customer] company's profit pressure is probably so significant that they would dispose of material or waste wherever they can achieve the cheapest price." (I5)*

Another key economic barrier is organisational inertia where companies resist change and maintain existing practises, which ultimately leads to the lack of circular economy innovations. Some waste management companies have decided to specialise in the landfill industry and only accept waste that cannot be utilised. As a result, the companies may not be aware of the potential benefits that productisation could offer and may overlook them. The landfill-focused waste management perpetuates linear practices, hindering the efforts to minimise waste generation and maximise resource efficiency.

A circular economy should be embedded well with the company's strategy. However, there is a lack of clear vision regarding the circular economy in some companies, which impedes the companies' commitment to the circular economy. Moreover, it was recognised that certain companies lack a unified vision across their organisational branches regarding the circular economy, resulting in differencing goals within the company. Consequently, a lack of unified clear vision across different branches of a company creates a fragmented approach to a circular economy while hindering the effective implementation of circular practices.

*"… we also do not have such a clear strategy for how we grow. We do have growth goals, but not in which direction to go." (I5)*

Despite the potential of the circular economy, high initial costs pose a significant barrier to the adoption of circular economy practices. Many companies perceived that a circular economy may be a risk as large investments, such as environmental permits and technology, are needed before any returns can be realised from the final product (I1 & 19). Additionally, the uncertainty around the benefits of circular economy practices may dissuade companies from investing in circular initiatives due to significant upfront costs.

*"… it is a pretty substantial risk for the company to go for it [circular economy]. --- … you have to invest quite a bit in it before you get to the point where you have the product in your hands. That is, the equipment, facilities, all the rest of that. And then if you do not receive an [environmental] permit for it, that will always be at the back of your mind. You have to plan really well to carry the idea." (I1)*

The focus of a company's investments must be extended beyond the immediate future. However, forecasting demand in the long term is difficult (I1, I5 & I9), and rapid changes in the market complicate the investing process. Particularly for small companies, investing in a circular economy may be risky due to limited resources which can restrict the capability of adapting to change and expanding business operations.

*"One should know a little bit further in the future. If we think that if the factory is invested now, let's say, whatever the facility is, it is an investment, and its deprecation period is 20 years. That way one must know for 20 years that it can be deprecated." (I9)*

The scope of the barriers extends beyond company operations to encompass market-level considerations. Waste-based materials require a market where there is demand, as without a viable market, productisation and reuse are difficult (I5 & I9). Most interviewees recognise that oftentimes circular economy initiatives are not yet economically viable in the industry. In the market, the pricing of waste-based material is compared to the virgin raw material, and most of the time, the virgin raw material is cheaper than waste-

based material (I1 & I5). On one hand, as awareness grows, customers increasingly seek environmentally sustainable solutions (I9). On the other hand, it is identified that customers are not willing to pay for a circular product or material if it is more expensive than virgin raw material (I5). Economic considerations continue to outweigh environmental factors in many companies. Despite the increasing awareness of the circular economy, clients are still hesitant to pay higher prices for more sustainable options (I5):

*"… in quite a lot of cases, the market dictates it [the use of waste-based materials], no one will pay 30 euros per ton of ash. You can already see it in real consumer prices." (I5)*

The companies in Peittoo are highly influenced by changes in other industries as the clients consists mostly of industrial operators from whom they receive construction waste, metals, and other industrial by-products. For instance, the ongoing recession in the construction industry has affected waste management companies as a shortage of material streams (I5). Consequently, companies have tried receiving materials from other industries, such as industrial operators, but there is not a lot of industrial production in the Pori area, resulting in a lack of materials and intensified competition over the materials between the companies (I5).

*"… the competition is fierce in that region, there are many operators, big operators in the circular economy field and they all are in Peittoo, so they compete over the same customers and same materials that they process." (I10)*

In the forest industry, there have been many ongoing circular economy projects for years (I5). Over the years, numerous circular economy projects have created a competitive landscape, and as a result, waste management companies struggle with initiating new innovative projects and solutions. The forest industry often has immediate access to materials and greater resources to work with, further complicating the competitive environment.

*"It is pointless for us to develop the utilisation of it [green liquor dregs] for something else at this point because they have larger projects there [in the forest industry], so it is not worth investing in it." (I5)*

There are already other companies processing the same materials and productise them, making it difficult to stand out (I5, I9 & I10). The decisions made by neighbouring companies within the circular economy park, as well as those in the wider area, profoundly impact other businesses' decisions. Rather than following a similar course of action, companies recognised that specialising in unique areas helps them to distinguish in the

market (I1 & I9). Nevertheless, companies encounter obstacles in uncovering new processing methods or utilisation purposes for materials that are not already undertaken by their competitors.

*“Again, we need to mirror it to the fact that there are other operators who are doing it [productisation], and there are already existing service offerings.” (I5)*

The location of the circular economy park was recognised as a barrier by all waste management companies as the clientele is far from the circular economy park, posing a challenge in the process of selling the materials. Thus, location and logistics hinder the circular economy when the material is transported to Peittoo for material handling and from there to the customers by trucks. Due to incurred substantial expenses, it is not always economically viable. In this instance, opting for virgin raw materials rather than waste-based materials may be more economically viable for the company.

*“From waste incineration, slag mineral is generated as a by-product, which could be used for land construction, but the costs associated with logistics are so substantial that it still cannot compete with the price of angular rock.” (I5)*

Another barrier regarding the location was identified. Numerous materials hold significant potential in reuse, yet where the mine waste (e.g., waste rock and tailings) is generated, often lie at a considerable distance from their practical utilisation. The most advantageous course of action considering the processing of mine waste would be to utilise the waste where it is generated, potentially developing localised processing capabilities near the site.

*“It is known that the problem is that the mines are somewhere over there far from where the material would be needed.” (I1)*

The absence of a clear price level for materials (I1 & I5) poses significant challenges to waste management companies, leading to potential financial losses. Without clear pricing levels, the market lacks stability and may undermine the competitive advantage of waste-based materials, inhibiting the transition to a circular economy. This is closely tied to linear approaches being more economically viable than circular practices.

*“There is no clear price level. There really are a lot of question marks, why they [competitors] offered such a price for this, and now [the material] was delivered to us. Sometimes we have missed tens of thousands extra money as we offered to take the material so cheap. But then again, the next case can be completely different. It is difficult to read the market.” (I5)*

## Environmental Barriers

All the identified environmental barriers were related to the material flows and the presence of hazardous materials that may prevent the reuse of certain materials. Certain materials are so hazardous that they are not suitable for reuse, such as waste incineration ash, which is considered hazardous to the environment due to its high chloride content so it cannot be reused (I5). Some other types of ashes can be reused, for instance, as structural fill for road construction or landfill construction (I5, I7 & I9). There are also other materials that are so dangerous to both human health and the environment that they must be sent to landfills, such as asbestos (I1, I5 & I7).

While extending the lifecycle of materials and products through reuse and repurpose are crucial in the circular economy, a comprehensive outlook on the sustainability aspect in the long run needs to be achieved in waste management companies, especially considering the long-term environmental impacts of materials. Some components within the recycled material or product may contain something that would be a burden to the environment in the future (I5). In the past, certain materials were deemed safe for use, but later they were discovered to be burdensome (I5).

## Institutional and Regulatory Barriers

Institutional and regulatory factors directly influence other factors, such as economic factors. As discovered in the theoretical background section, often these institutional and regulatory factors are seen as drivers to the circular economy, but many barriers were found, especially regarding the environmental permits. Regulations, such as tax policies, influence the pricing of both virgin raw materials and waste-based materials which may incentivise companies to incorporate circular practices. One of the key regulatory barriers is the insufficient legislative promotion of waste-based materials.

*“The obstacle to the productisation and reuse is that there always has to be a market for those waste-based materials. Then also such a price that it is worth it. And this is governed by legislation.” (I9)*

Four out of five waste management companies recognised that environmental permit application processes slow down circular economy (I1, I4, I5, I7 & I8). Among the primary barriers encountered is the preciseness and inflexibility of environmental permit applications. Environmental permit applications require precise information about factors, such as used technology, materials, and the amount of each material that is planned to be received from customers, which makes the process difficult as companies should predict the material streams that may be available in the future. Another barrier to achieving a

circular economy is the requirement for environmental permits when producing products for external use. Companies lacking particular permits are unable to productise their materials for external use, but they can only utilise them internally, restricting the innovation process and adding complexity to productisation.

*“At the moment, we have not been given the option in the environmental permit that we could produce the products externally, but only for internal utilisation. We can use them here for construction and replace the virgin aggregate.” (I5)*

Adopting circular economy practices in waste management involves utilising materials, which often necessitates productisation (I1 & 19). However, if the existing environmental permit does not cover specific materials or methods, obtaining a new permit becomes necessary for productisation. The lengthy, costly, and rigid environmental permit application process makes applying for a permit complex (I1, I4, I5, I7, I8 & I9). Furthermore, it is recognised that operators typically only apply for a new environmental permit when significant changes or innovation ideas are planned, besides external requirements, due to the length and costs of the application process. Frequently, this slows down the innovativeness of companies because certain innovation ideas are not deemed significant enough for applying for a new permit, that being the only new component in the permit. Most interviewees highlighted that when evaluating material streams, they are not allowed to process, the company encounters a crucial decision: should they apply for a new environmental permit specifically for that material stream, or is it more practical to address simultaneously during the process of applying for other permits? Thus, the current environmental permit process is found to discourage companies from innovation and instead reinforcing adherence to established, typically linear practices.

*“The environmental permit application process is time-consuming and costs. One needs to assess whether the waste stream is so large that it is worth seeking the permit change immediately or if it is more prudent to wait until the next permit change.” (I5)*

As the linear economy has long been the dominant economic model, well-established circular economy practices are not always readily available for adoption in waste management. Consequently, companies must innovate and devise their approaches actively to successfully transition from linear to a circular model. However, the plan should be well advanced before the company applies for an environmental permit (I1, I4, I5, I9 & I10) as the application process requires precise details, occasionally to the degree that companies struggle to provide the information.

*"… if one wants a new activity, one has to be quite sure about the new activity, and somehow thought long and hard before one even finds out if there will be a permit for this." (I4)*

As environmental permits strictly define how and what materials companies are allowed to process, changes in the market may pose difficulties to the companies. Often, it is not possible to react quickly to the market which leads challenges to be flexible with customers (I1, I5 & I9). Moreover, circular economy opportunities may arise unexpectedly, and the company could miss out on these opportunities due to the slow process of changing an existing permit. If the company applies for a permit change, the opportunity may have already passed as oftentimes these situations involve customers possessing materials that companies cannot acquire. As a result, operators apply for environmental permits for certain methods or materials as a precaution for future needs (I1, I5 & I9). From a regulatory perspective, companies with more expansive environmental permits can undertake a broader scope of actions, granting the operators greater flexibility and latitude in their operations.

Another identified barrier is the tension between the existence of highly specialised waste codes that customers possess and incompatible environmental permits. These waste codes may be so rare that waste management companies may not be able to obtain the material, leading to customers being unable to get rid of it. Oftentimes, waste management companies would have the capability to process it, but due to the limitations of their environmental permit, they are prevented from accepting it.

*"We have the EWC code, i.e. the waste catalogue listing, which is attached to the environmental permit, so we have needed to list each waste code separately. And if there are small waste flows from the industry, there may be such a specific waste code that we do not have an environmental permit for. Then comes the problem that it would be fine for us, but we cannot take it because we do not have permission for that code, and then the customer cannot get rid of it because there is no place that could obtain it." (I5)*

According to the Waste Tax Act, the final disposal of taxable waste is an activity that necessitates an environmental permit for landfills (EEA, 2023). Waste that can be recycled or recovered using established methods is subject to waste tax, which landfill operators are liable to pay (Vero, 2024). Certain categories of waste are tax-exempt, such as hazardous waste (I9) and waste that is utilised for landfill construction (Vero, 2024). As the Waste Tax Act defines what waste is subject to waste tax, it significantly impacts the pricing of materials in the market. Further, sometimes different interpretations by tax administration result in unequal situations between companies. Although this act is aimed

to promote sustainability and circular economy practises, some companies falsely claim material utilisation, and gain an unfair competitive advantage, and may even divert resources from companies that are truly committed to sustainable practices.

*"In a way, we have to interpret the construction waste part of the contaminated soils in a different way. And it affects those prices terribly. The fact that if someone else has a price of 13 euros, we have to ask for the same 30 euros." (I1)*

*"… some of our operations may cost us a million euros, while our neighbour's [same operation] costs 500,000 euros, which creates unfair competition." (I8)*

The role of authority is to ensure equality between operators. In some instances, the supervisory authority can use their discretion in supervising wastes, which can lead to differing decisions in different parts of Finland (I9). Differing interpretations of the law by authorities have also resulted in company-specific environmental permits wherein some companies may have requirements other companies do not have, typically regarding the monitoring of activities (I1, I5, I7, I8 & I9). However, the location of the activity and the delicate nature of the environment are region-specific, and the combined impacts of the activities in the area are all assessed in the environmental permit application (AVI, no date), which partially explain the differences. While operators' environmental permits may differ, valid justifications exist, which consequently, underscores the need for enhanced communication from authorities to maintain transparency in the process.

Securing an environmental permit for circular economy projects may prove to be challenging (I1). Due to the innovative and unconventional nature of the circular economy, assessing the environmental impact poses challenges for permit approval. Another barrier is the difficulty to monitor the material, particularly demolition waste, that is suitable and safe for reuse (I1 & I2) without endangering human health or the environment.

*"In principle there are already existing processes, so that it would be suitable material that could be used. But in a way, the monitoring is probably the most problematic part of it that how it can be proved that it is always usable for these destinations." (I1)*

Outdated infrastructure was identified as an institutional barrier by most actors. The drainage pipe that connects Peittoo to the sewage treatment plant is weathered, thereby the actors of Peittoo transfer water by a tanker, incurring additional expenses and causing environmental harm, including higher carbon emissions. Infrastructure maintenance and upgrades are crucial for ensuring sustainable water management practices, reducing transportation emissions, and ultimately supporting the transition to a circular economy.

*“In Luotsinmäki [the sewage treatment plant], the inlet of the pipe is made of concrete, and they are afraid it corrodes because of the amount of salt in our waters. There would be the infrastructure for it [transferring the water] in principle, where it would be a little more cost-effective, with less environmental harm --- … but those are the limiting values of the sewers that they have at the moment, and they do not make concessions.” (I5)*

Another barrier regarding the infrastructure is a lack of space for waste storage and material handling (I5). Circular economy practices require a lot of ground space, yet the circular economy park is constrained by limited available space. Additionally, the wind power plant operating in the area imposes a slight constraint on land use as the underground cables limit construction possibilities.

*“The wind power plant is quite dominant here. It is relatively difficult for us to build, those sewer and water lines were also difficult, because the cables of the wind power plant are under the ground.” (I5)*

Frequent and sometimes unforeseen changes in legislation limit the adaptation of circular economy practices. While EU-level legislative changes are eventually incorporated into Finland’s national legislation, one of the interviewees pointed out that EU legislation tends to be clear, whereas national laws often are shortsighted and neglect long-term implications (I9).

*“Most likely, everyone working in this industry aspire for legislators to take a longer line on things. And in any case, a clear outline in legislation has been established by the EU. But then we have this national legislation.” (I9)*

Country-specific laws and regulations were identified to create barriers to the global transition to a circular economy. During the interviews, the proximity of the port was seen as an advantage, offering unique opportunities for companies, from a materials standpoint. However, during the group discussion, it became evident that utilising the port is challenging due to regulations because the global importation and exportation of materials may not always be legally straightforward. These country-specific laws and regulations significantly hinder the systemic transition to a circular economy globally across different countries.

Environmental Impact Assessment (EIA) should ideally be conducted during the planning phase, prior to the environmental permit process (I3) as it was designed to be a planning tool, but in most cases, they are carried out simultaneously (I2 & I3). This is due to the lengthy approval processes: environmental permits typically take 10-12 months and EIAs require a minimum of a year (I2 & I3). Companies usually aim to conduct the

environmental permit application process and EIAs simultaneously for strategic and operational reasons, but considering environmental factors, this approach may not be the best practice. If the EIA procedure was conducted before applying for environmental permits, companies could better focus on choosing the most optimal alternatives, including location, capacity, and methods. This approach would better serve the environment, and environmental impacts could be minimised. This is a recognised tension between environmental factors and business decisions where companies typically prioritise time-savings.

## Sociocultural Barriers

A transition to a circular economy is influenced by significant sociocultural barriers. The most significant barriers were a lack of collaboration among the actors of Peittoo (I1, I4, I5, I7, I8 & I9), which is identified as a local circular economy park factor, and insufficient collaboration with other industries (I1, I5 & I10). Adopting systems thinking is a global circular economy transition factor, which is at the centre of a successful transition to a circular economy, and therefore, more organised collaboration is needed. Currently, the material follows a direct path to the designated operator responsible for its disposal with no circulation between the operators, possibly leading to missing opportunities for identifying components that could be reusable or recyclable.

*"… materials are not exchanged very much … - - -, and the materials stored and received by each other are not utilised, so that everyone is just doing their own business." (I10)*

The insufficient collaboration between waste management companies and other industries, such as heavy industries, inhibits the adoption of circular economy practices on a larger scale. A broader consideration over the lifecycle of materials requires strong communication between actors beyond industries. For instance, there is no collaboration between the forest industry and waste management companies, and they mainly innovate alone. However, with co-innovation the companies could come up with innovations that no one would have managed to think of alone, co-creating value. In line with the theoretical framework discussed earlier, the results of this study underscore the ongoing emphasis on recycling over waste prevention in waste management. To enhance waste prevention practices, collaboration between waste producers and waste management companies should be improved as waste prevention starts from designers' material choices.

*"If they [the forest industry] requested help with innovation, then ok, but there is no clear request from them. They have many innovation projects ongoing now as well." (I5)*

Based on the interviews and group discussions, it was recognised that the industry itself is conservative and changes slowly, inhibiting the circular economy transition. All waste management companies that participated in the study are relatively old, with the youngest among them having been in operation for 20 years and the oldest for over 110 years, thereby the established habits and ways of thinking support old practices that are mainly linear. The companies may be entrenched in their practices and resistant to change which can slow down or disrupt the innovation process. Additionally, when the companies were founded, a circular economy was not part of their core business, for which reason the adoption of CE practices may be challenging.

A lack of circular economy knowledge was identified to hinder the adaptation of circular economy practices as the potential benefits of circularity may be unclear. Implementing new circular economy practices requires broad knowledge of individuals within companies to successfully enable the CE. Some companies perceive circular economy primarily as recycling, failing to recognise a more systemic approach. As a result, companies may lack a strategic implementation of a circular economy and miss circular opportunities.

Given the constraints on collaboration with current actors operating in the area, it is identified that new actors emerge as a requisite for enabling new circular economy practices and collaboration. However, no new companies have commenced business activities in the circular economy park which is seen to inhibit the transition. The lack of interest from new companies may stem from the current state of the circular economy park, characterised by limited collaboration and a lack of robust circular economy practices.

## Technological and Information-Related Barriers

Many identified circular economy barriers regarding technological factors were related to materials and the processing of them. Technology itself has advanced considerably and is not generally a barrier to a circular economy anymore, but a lack of competitive technology is (I5, I7, I8 & I9). A technological capability is often hindered by unsustainable and inefficient operational processes. The methods used to handle certain materials, often consume a lot of energy and fuel, making the processing unsustainable and expensive. In such cases, the negative environmental impacts may outweigh the potential benefits, underscoring the need for more sustainable methods. The costs that occur when materials are processed hinder the circular economy as it often still is significantly more cost-effective for companies to dispose of the waste than productise it with the available technology.

*“In the same way the contaminated soil, namely oil-contaminated soil, could be treated [converted contaminated soils into non-hazardous soils], but the combustion equipment that burns it, consumed hundreds of litres of fuel per hour for heating, for that combustion reaction.” (I5)*

While most of the interviewees asserted that technology is no longer a barrier to achieving a circular economy, some interviewees identified a lack of technology still a barrier. A lack of technology may hinder circular economy practices because finding a suitable method or technology can be difficult for certain materials (I5 & I7). There are materials that can be processed but still a significant portion of waste ends up in the landfill as the technology is not suitable for fully processing it. For instance, while it is possible to separate chloride from the ash, the residual ash is still disposed of in landfills even after the removal of chloride (I5 & I7). Additionally, certain metal particles are so small that they cannot be separated with the current separation equipment (I5).

The traceability of materials is often obscure as intermediary actors are often involved when a customer offers materials to the actors of Peittoo (I5). This makes it difficult to trace down where and from whom the material is coming. Understanding the quality and origin of the material directly impacts the consistency and utilisation targets of these materials. Additionally, due to intermediary actors offering the materials, it is difficult to contact customers and build deeper business-client relationships, simultaneously complicating the process of finding suitable material streams.

*“A potential customer called and asked about foundry sand, but I could not find out which company it was, because there was an intermediary actor involved again.” (I5)*

## 5.3 Factors Driving the Innovation Ecosystem Emergence

This section presents the identified drivers to the innovation ecosystem emergence. Some drivers include potential collaboration ideas that emerged during interviews and group discussions but have not yet been implemented. However, they were perceived to hold the potential to drive the ecosystem emergence and transformative change. Additionally, the forward-looking mindset is essential in innovation ecosystem development, which is why these drivers were included. The identified driving factors are categorised into five categories, which are (1) economic benefits, (2) development of shared infrastructure, (3) regulatory-driven collaboration, (4) inter-organisational dynamics, and (5) information sharing and material resource dynamics.

### 5.3.1 Economic Benefits

Economic benefits were identified as primary drivers for innovation ecosystem operations, with each interviewee emphasising the paramount importance of economic viability. While all the actors of the circular economy park expressed interest in collaboration, its economic viability was a crucial factor for innovation ecosystem participation. Alongside the desired financial gains, actors recognise the need for novel innovations from collaboration. They anticipate that the efforts in ecosystem activities would not only benefit the broader ecosystem but would also boost business operations for their individual companies.

*"One would need to get money from that collaboration and new ideas… --- … it would be meaningful for us to get new activities and turnover, and perhaps expand our operations to some direction from the current one." (I4)*

As noted earlier, the current operators emphasised the need for new participants in the circular economy park. In response to the need for new businesses, the ongoing zoning process aims to provide new opportunities for businesses, seeking new actors to enhance collaboration. In other words, the inclusion of new actors could invigorate collaborative efforts, and therefore, drive the emergence of the innovation ecosystem. New entrants could foster interactions and activities of the nascent ecosystem by filling the missing complementary roles and unlocking synergies. Based on the group discussions, the circular economy park would need an actor capable of receiving, pre-processing, storing, and producing products. This would allow a new operator to access materials from incumbent actors and process them with innovative technology or methods. As a result, the circular economy park would benefit from improved material flows and enhanced collaborative efforts.

### 5.3.2 Development of Shared Infrastructure

As identified through interviews and group discussions, shared infrastructure was identified to play a crucial role in the emergence of an innovation ecosystem. The waste management companies are co-located in the area, lowering the threshold for inter-organisational collaboration. Ideally, the co-located actors optimise their operations by promoting the exchange of materials and information. One concrete, potential idea was identified, which is the need for improving wastewater processing (I1, I5, I7 & I8). All Peittoo operators must process their wastewater, and currently, it is undertaken individually. The idea of locally processing wastewater in collaboration was highlighted by several participants during both interviews and group discussions. The idea would not only

address a critical environmental challenge but would also foster collaboration and draw attention and interest of companies outside the current operating region.

### 5.3.3 Regulatory-Driven Collaboration

The collaboration between the companies is mainly driven by regulations, particularly regulatory requirements related to environmental permits. The current environmental permits mandate operators' involvement in joint monitoring of water quality, fostering collaboration among them. The joint monitoring of water quality, thus, stands not only as a regulatory tool but also as a facilitator for enhanced collaboration, thereby driving the emergence of the innovation ecosystem. This regulatory requirement compels the operators to collaboratively monitor and uphold water quality, necessitating coordinated efforts. As trust is critical for the emergence and growth of the ecosystem, trust gained from the joint monitoring of water quality may be the cornerstone of initiating ecosystem activities.

*"In the environmental permit, there is a permit requirement that they have to participate in joint monitoring of water quality." (I3)*

*"What is released into the ditches and groundwater, that is joint monitoring of water quality, and the environmental permit obligates us to be involved." (I4)*

### 5.3.4 Inter-organisational Dynamics

As innovation ecosystems consist of complex networks of actors, the inter-organisational dynamics play a critical role in these ecosystems. Collaborative meetings held for joint monitoring of water quality and some informal topics serve as a significant social driver for the ecosystem emergence, strengthening the dynamics of the Peittoo actors. These collaborative meetings were proven valuable for other types of collaborative endeavours, extending beyond environmental permits. By broadening the scope of discussions, stronger relationships are fostered and a more holistic approach to ecosystem activities is created.

It was identified that the already existing collaboration, such as renting an interim storage facilities or equipment, may drive the emergence of the innovation ecosystem as it lays a solid foundation for trust among organisations. The early interactions between actors were additionally identified as a key driver in the emergence. When companies come together to engage in ecosystem activities, they exchange valuable information and knowledge with the ecosystem participants, requiring trust to be developed to some degree. It was noted that the actors have prior acquaintance and positive rapport due to

collaborative meetings, which serve as a driving factor to the innovation ecosystem emergence.

*"… people get along well in my opinion, and communication is, at least what I believe, easy. If you have any questions or anything else, there is nothing [that could not be asked]. In my opinion, collaboration sounds possible. --- … When we have had these collaborative meetings, I think they have gone in a good spirit. But, of course, they are now related to this (joint) water quality monitoring, not business." (I4)*

### 5.3.5 Information Sharing and Material Resource Dynamics

All actors expressed interest in exchanging information related to environmental permits with each other. However, some actors encounter limitations in sharing specific environmental permit-related information due to limited experience but are alternatively willing to share information in other domains, for instance, regarding construction. When the actors share their expertise, it enriches the ecosystem's knowledge base and broadens the range of information exchanged. Information sharing is a foundational element in a successful emergence of an ecosystem that allows actors to effectively address complex challenges, achieve shared goals, and innovate.

*"Often, we would probably be on the receiving end of it [environmental permit information]. Of course, the information related to construction, mechanical work, etc. would probably go from us to the other direction as well." (I4)*

The identified potential for collaboration in material handling was substantial. Firstly, the operators have different environmental permits wherein some companies are allowed to productise the waste while other companies may only be allowed to landfill it. Thus, if one company cannot effectively utilise the acquired material, they could foster collaboration by permitting other companies to process or utilise it (GD2, I1, I7 & I9). Secondly, both interviews and group discussions revealed significant collaboration potential in the transportation of materials within the ecosystem to optimise material flow. Co-located waste management companies can coordinate their transportation efforts to reduce both environmental impact and costs.

## 5.4 Factors Inhibiting the Innovation Ecosystem Emergence

As the ecosystem has yet to fully form, notable barriers were encountered, which need to be addressed before the innovation ecosystem has successfully emerged. Recognition was given to the multi-faceted nature of certain barriers, some of which create ten-

sions within the ecosystem. The barriers to innovation ecosystem emergence were categorised into four distinct categories: (1) competition, (2) regulatory incompatibility, (3) lack of shared vision and commitment, and (4) lack of information sharing and shared platform. At the end of this section, figure 6 synthesises both inhibiting and driving factors that impact the emergence.

### 5.4.1 Competition

The most prominent innovation ecosystem emergence barrier was intense competition, which was brought up by all participants. The current competition poses a significant challenge to collaboration and prevents the ecosystem from emerging. Innovation ecosystems thrive on a delicate balance between cooperation and competition, a phenomenon referred to as coopetition as discussed in chapter 3. Currently, all actors in Peittoo operate in the same market with similar operations, making the exploration of synergistic opportunities difficult. Individuals' competitive mindset has, moreover, resulted in reluctance to engage in collaborative activities, hindering the emergence of an innovation ecosystem.

A conflicting barrier to co-innovation arises from the tension between ecosystem value and company value. While the focus of innovation ecosystems is on collective output and the shared value that is created for all participants, companies need to consider their own interests, too. However, currently, the tension between ecosystem and company values hinders the ecosystem emergence, as companies predominantly focus on their own value, ignoring the ecosystem value. An ecosystem participation requires that actors recognise the value and actively participate in developing the ecosystem activities. Nevertheless, companies fail to grasp the value they would gain from ecosystem activities, which negatively affects their willingness to engage in these activities.

The companies compete over same material streams, and typically the customers compare prices between the companies to find the best deal for the lowest price (I5). The competition over same material streams and customers intensifies the competitive dynamics between companies and makes it difficult to establish synergistic relationships necessary for the ecosystem growth. On one hand, all businesses involved in the area express interest in collaboration, but on the other hand, the participants highlight the intense level of competition, which they believe obstructs the possibility of inter-organisational collaboration.

*"There is much more competition here than in our other units." (I5)*

While some interviewees portray the communication as easy and open, allowing them to ask for assistance from other actors, it is also noted that excessive competition inhibits truly open communication. The intense competition, especially among larger companies (I1, I4, I9 & I10), hinders the successful emergence of the ecosystem. As companies naturally compete, the ecosystem participants are required to shift their mindsets from competition to coopetition.

### 5.4.2 Regulatory Incompatibility

In recent years, the complexities associated with obtaining environmental permits have roused operators' interest in collaborative approaches, although active collaborative initiatives have not been initiated beside the joint monitoring of water quality. The stringent regulations and rigorous scrutiny in the environmental permit process has resulted in delays and uncertainty among operators as the application process lacks clarity on compliance requirements (I1, I4, I5, I7 & I8). Consequently, some operators have hesitated to apply for new environmental permits and continued business operations with their current practices as described previously. Collaboration in environmental permits stood out as one of the most potential collaboration opportunities. However, given that each environmental permit process progresses at a different pace, collaboration is recognised to be challenging (I1).

*"In this respect, it is difficult to cooperate, because each permit process moves forward at its own pace. And in a way, everyone has the need to apply for the permit at different times. That way, it always proceeds at a different pace. So, I see that the authority would have a bigger role in it [improving the process] as authority's role is to guide, resolve, and advise." (I1)*

Businesses increasingly recognise the importance of specialisation to gain a competitive advantage, and furthermore, acknowledge the significance from a collaborative standpoint. As innovation ecosystems consist of complementary actors that strengthen synergies among the ecosystem participants, specialisation is somewhat necessary. However, regulations pose a contradicting barrier to innovation ecosystems as the fear of inadvertently creating a cartel may deter operators from deciding to specialise in conjunction with other companies. Thus, clear regulatory guidelines should ensure that businesses can pursue specialisation strategies without unintentionally contravening with law.

*"… how the collaboration could be [built], when dividing markets is illegal, 'you do this and I do that and I take the money', that is a cartel. A better solution should be devised.*

*---- …. A cartel is when the market is divided knowingly and when prices are fixed that no one else can join the competition." (I9)*

### 5.4.3 Lack of Shared Vision and Commitment

Various barriers were identified regarding the commitment of innovation ecosystem participation. The insufficient commitment of participants may, however, stem from a lack of shared vision within the emerging innovation ecosystem. Without a shared vision, the purpose of forming an innovation ecosystem may remain unclear, hindering actors from recognising its value, and potentially disrupting the ecosystem's emergence. Based on the group discussions, it was evident that most participants showed reluctance to collaboration, which may also be a result of not having a clear shared vision and goals.

The existing collaborative meetings are mainly driven by joint monitoring of water quality and do not cover innovation or business-related matters (I1, I4, I5, I7 & I9) as a competitive mindset inhibits collaboration, posing a notable barrier to the emergence of a holistic innovation ecosystem. A multi-faceted approach that goes beyond a singular focus is necessary in a successful innovation ecosystem. During the interviews, many actors proposed that the meetings could encompass broader topics, such as co-innovation. On the other hand, during the group discussions, the prevailing view suggested that the collaborative meetings address all relevant topics and participants saw no room for further improvement. The actors' hesitancy to drive the change inhibits the emergence of the ecosystem and the further development of collaboration.

In addition to jointly monitoring water quality, the collaboration is limited to companies engaging with each other in a business-client relationship, where one acts as a client (I1, I4, I5, I7 & I9). This implies that the lack of wider engagement poses a significant barrier to the emergence of the ecosystem. When companies' interactions are only limited to traditional business-client relationships, the broader benefits of ecosystem activities are missed out. Broader engagement is necessary for innovation ecosystem growth and development. In the emerging ecosystem, another significant barrier is that collaboration heavily relies on certain individuals, contributing to companies favouring traditional bilateral collaboration over multilateral approaches.

While all of the circular economy park actors express interest in collaboration, inquiries about enhancing collaboration yields little progress as no specific ideas are put forth. The activities and operations of Peittoo circular economy park have stagnated over several years without any significant development (I6). Without an orchestrator to facilitate and guide the development, the ecosystem's emergence is unlikely to be successful.

*"I believe that there must be someone who organises the activities and maybe operates them. It [the orchestrator] is missing. ---- …. The circular economy park has not really been developed at all. There is no one to take care of it or organise or operate it. And this has been the biggest shortcoming here." (I6)*

To date, the city and actors in Peittoo have not engaged in collaborative efforts with each other. However, insights from group discussions indicate that actors are hoping to receive support from the city and would be willing to engage in collaboration. The city has its own vision of the future of the circular economy park, which is not sufficiently communicated or shared with the companies. The lack of collaboration between private and public actors ultimately hinders the collaborative efforts and development of Peittoo.

In 2014, an investigation to support the development of Peittoo's business concept was conducted to understand the direction of development and potentials (Ramboll, 2014). To this day, the question about new suitable actors in the area remains unanswered as it remains uncertain which companies would be suitable and who would be interested in joining the circular economy park. The development and emergence of the innovation ecosystem may be inhibited due to a lack of promotion and marketing efforts for the area, leading to business opportunities being invisible to other businesses. Therefore, other businesses may not be willing to operate in the circular economy park.

### 5.4.4 Lack of Information Sharing and Shared Platform

At present, one of the key barriers encountered by Peittoo circular economy park is that data or information does not flow between the organisations (I1, I4, I5 & I7). In addition to the absence of established information-sharing practices, another significant barrier was the reluctance of actors to exchange information. The paradoxical barrier was that while all actors desired to exchange information, they simultaneously ensured they do not divulge any information to others. It appears that there is a keen interest among operators to receive information, but there is noticeable hesitancy to share information they possess. Particularly, the competition among bigger companies was identified to impede information sharing.

*"Yes, such an exchange of information would definitely be good. Sometimes in earlier years we have gotten a little help [from other actors], so it is easy for us to ask how they managed to do something. But maybe it is not so easy among those bigger actors." (I4)*

Another major barrier is the absence of a shared platform for communication and collaboration among operators. A shared platform is fundamental to the process of innovation ecosystem emergence and without it, a dissemination of information relies solely on word

of mouth. A shared platform is crucial for organising collaborative efforts and cultivating transparency and trust among ecosystem participants. Without a shared platform, actors cannot effectively exchange vital information, coordinate their activities, or share resources, which ultimately may result in a lack of commitment, as there is no cohesive force binding the actors together.

The city's role in providing infrastructure, zoning, and creating new business opportunities for the circular economy park is critical, which calls for communication between the city and actors. However, the absence of a shared platform between the city and actors of Peittoo has resulted in a lack of communication. Based on the group discussions, the incumbent actors are unaware of the progress of zoning, which creates uncertainty and may hinder planning for the future. Without timely updates and communication between the city and operators of Peittoo, the development of the whole circular economy park is inhibited and may not reach its full potential.

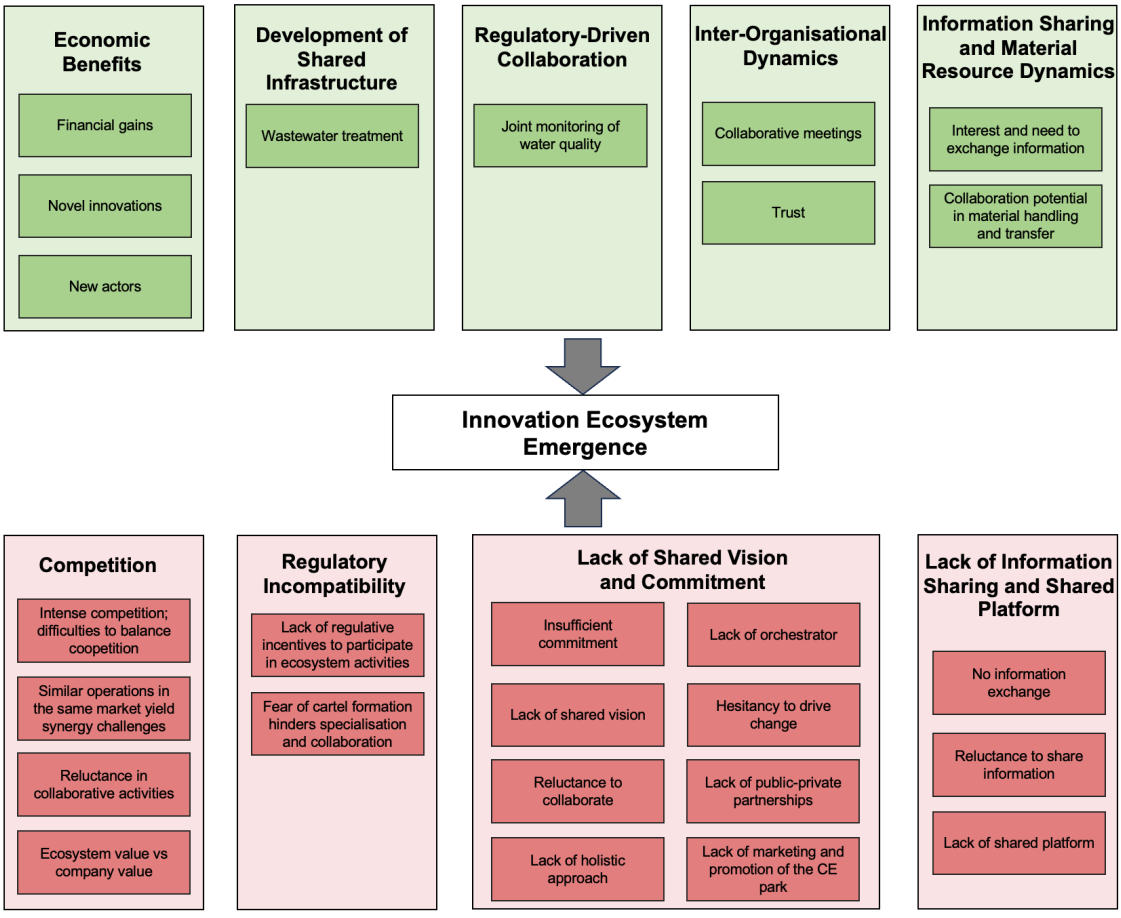


***Figure 6.*** *Innovation ecosystem emergence drivers and barriers.*

## 5.5 Summarising Circular Economy Transition and Innovation Ecosystem Emergence Drivers and Barriers

This sub-chapter summarises the key results to research questions 1 and 2, presented in the following order: CE drivers, CE barriers, followed with innovation ecosystem emergence drivers, and lastly, the emergence barriers.

The primary underlying driver for the transition to a circular economy is rooted in environmental factors.

- The shift from the linear economic model to the circular economy is largely driven by the urgent need to address pressing environmental challenges including climate change, biodiversity loss, and resource depletion, among other things.

Many legislative factors stem from environmental factors, such as tightening sustainability regulations, EU's recycling targets, and taxation that guide the transition.

- Environmental permits granted by the Regional State Administrative Agency play a critical role in protecting the environment and human health by regulating and tracking activities across regions.

Sociocultural factors are significant in driving the circular economy transition.

- As societal awareness grows, consumer behaviour and cultural attitudes shift, resulting in consumers demanding more circular products and services. In essence, as the demand for circular solutions increases, the market responds by increasing the supply of circular products and practices, driving the circular economy transition.

Furthermore, technological and information-related drivers are key enablers of circular practices.

- As the waste management companies handle industrial by-products, there is a vast variety of materials that can be processed with today's modern technology. Additionally, there is ample opportunity for innovation to find new ways to process industrial by-products which is also supported regulatorily by AVI's environmental permit application priority processing of green transition projects.
- The new ways to gather and utilise data carry the potential to enhance circularity by making informed decisions.
- Currently, there is no database or databank that would provide information about available materials within the circular economy park or surrounding areas, but to support the systemic change it is recognised to be a valuable tool in the transition.

Moreover, economic drivers hold a pivotal role in shaping the circular economy, compelling companies to act.

- Affordability of circular processes and practices is identified as one of the most critical economic drivers, which is heavily shaped by the current legislation.
- The ongoing zoning process of Peittoo will enable new business opportunities in the future wherein the role of the city is important.

The most prominent barriers in a circular economy fall under economic, institutional and regulatory, and sociocultural factors. The economic barriers are addressed first:

- Companies prioritise economic considerations over environmental matters, hindering the transition to a circular economy.
- Another significant economic barrier to a circular economy is a lack of clear vision in companies.
- High upfront costs, rapid changes in the market, and the pricing of waste-based materials are all significant macro level economic barriers that could partially be solved with laws and regulations.

The current legislation is insufficient in promoting the use of waste-based materials and their use is not sufficiently incentivised.

- Environmental permit application processes are perceived to slow down the circular economy innovation as they are rigid, long, and expensive. The application process does not align well with the innovative nature of the circular economy as circular economy initiatives necessitate rapid innovation while the environmental permit process requires comprehensive information and detailed planning. Consequently, especially smaller companies may choose to adhere to conventional methods they already have an environmental permit for, instead of applying for environmental permits for new circular economy initiatives.
- The national legislation is identified to be shortsighted with inconsistent and rapidly changing regulations, creating uncertainty for businesses in pursuing circular economy initiatives. Moreover, country-specific laws and regulations hinder the systemic adoption of circular economy opportunities globally.

The implementation of circular economy necessitates collaboration across industries.

- However, the collaboration among the actors of Peittoo and between industries is insufficient, and the focus is mainly on their own individual business operations.

- As the industry is conservative, with practices deeply rooted in traditional linear models, there is significant resistance to change towards circularity. This is evident in customers limited willingness to pay higher prices for waste-based materials than virgin raw materials, simultaneously making waste management companies hesitant to switch from their established practices.

The lack of competitive technology is a major barrier to the transition in a circular economy.

- Although there are many technologies that can be utilised, material handling is oftentimes expensive and unsustainable.
- Moreover, some materials and components are hazardous, posing challenges in the reuse of certain materials.

The key drivers for the emergence of an innovation ecosystem are the economic viability of ecosystem activities as well as social factors.

- In order to motivate actors to participate in innovation ecosystem activities, the participants look for tangible benefits, such as financial gains, novel innovations, and exchange of information and resources.
- Trust is a core factor of building business relationships within an ecosystem. Through business-client relationships and collaborative meetings regarding the joint monitoring of water quality, the actors communicate with each other, building trust and deepening relationships. However, trust is developed gradually, requiring consistent efforts from all participants.
- As the innovation ecosystem has not emerged yet, some ideas of collaborative activities were identified, such as interest in exchanging information and collaborative efforts in handling and transferring materials that were identified as a significant driver for the emergence.

Based on this study, social factors emerge as both the most significant drivers and barriers to the emergence of an innovation ecosystem. Collaborative activities are largely inhibited by the intense competition between the companies, which also hinders the emergence of the innovation ecosystem.

- The competitive mindset has resulted in reluctance in collaborative activities and hesitancy to drive change and collaboration.
- As the emerging ecosystem lacks an orchestrator who would organise the ecosystem activities, create a shared value proposition, and lead the ecosystem to

achieve the value proposition, the goals remain unclear, which consequently leads to a lack of commitment from individuals.

- While interest in information exchange drives the emergence, as previously mentioned, a significant barrier lies in individuals' resistance to share information.
- The most significant emergence barriers are the lack of value proposition, lack of orchestrator, lack of commitment, and intense competition, which obstruct the emergence process.

Based on the identified drivers and barriers, a successful development of a circular economy park relies on active collaboration among its stakeholders. Despite the numerous barriers, there are no proactive efforts for addressing them. Companies tend to prioritise individual business activities over collaborative efforts, which makes overcoming barriers complicated. The drivers must gain greater significance for participants in order to motivate them to collaboratively contribute to the growth of the circular economy park.

## 5.6 Interconnectedness Between Circular Economy and Innovation Ecosystems

The circular economy park's development involves transitioning to a circular economy and fostering an innovation ecosystem where the factors impacting them are intrinsically interconnected. To holistically navigate the complex interplay of actors, relationships, and structures, both the circular economy and innovation ecosystems require systems thinking rather than focusing solely on individual components. Although the drivers and barriers were identified individually and categorised into separate sub-categories, they are inherently interconnected and multi-faceted, influencing each other in intricate ways. For achieving systemic change, it is crucial to manage both processes: innovation ecosystem emergence and the transition to a circular economy. In this study, more barriers were highlighted than drivers, which underscores the complexities of these two processes. Perhaps the adoption of circular economy practices and inter-organisational collaboration are still in their early stages, which is why more challenges were recognised. Barriers to both circular economy transition and innovation ecosystem emergence may be presented as a vicious circle where initial barriers result in additional obstacles, reinforcing each other and making them more complex to tackle. As the identified barriers are multi-layered, intersecting various dimensions (e.g., economic, societal, etc.) and levels (micro, meso and macro), addressing them requires a holistic and coordinated approach that simultaneously considers all aspects. While the study approached the circular economy transition drivers and barriers from the perspective of companies, the

majority of the uncovered factors were related to broader systemic forces. Most factors impacting the circular economy transition emerged on macro level, such as regulatory landscape, market dynamics, and societal forces. The innovation ecosystem emergence drivers and barriers while systemic, emerged mostly at micro and meso levels, emphasising the interactions between companies.

Both concepts thrive on collaboration, and neither can succeed alone solely through the actions of an individual company. A successful transition to a circular economy necessitates collaboration while participation in ecosystem activities enhance it. Social barriers were considered significant in both circular economy and innovation ecosystems. The intense competition between the actors of the circular economy park currently inhibits the transition to circular economy and emergence of the innovation ecosystem, making it difficult to find synergies within the circular economy park and across industries. In the context of the innovation ecosystem emergence, the fierce competition prevents open communication and establishment of trust. As the companies operate within the same sector, engaging in nearly identical operations, serving the same customer base, and competing over the same materials, both circular economy practices and innovation ecosystem activities face hindrances due to the lack of existing synergies. Based on this finding, it can be argued that some level of specialisation is needed to engage in collaborative activities that complement each other.

Regarding the synergies, the role of new entrants is significant in catalysing both circular economy and innovation ecosystem emergence. Their entry was viewed to enrich the collaborative landscape and expand the realm of possibilities by bringing forth new resources, operations, and expertise. Nevertheless, the circular economy park does not appear compelling to newcomers. Collaboratively the city and actors of Peittoo would need to develop a strong brand for the circular economy park and promote it through marketing campaigns. Currently, the city has its own vision of the park, but in practice, the actors have remained uninvolved, focusing solely on their company-level strategies.

Central to the circular economy and innovation ecosystems is the sharing of information and resources. However, in the Peittoo circular economy park, neither information nor resources are exchanged, which hinder various circular economy opportunities as well as the emergence of the innovation ecosystem. Based on the findings of the study, the actors exhibit a reluctance towards sharing information and resources, primarily due to the lack of shared goals and a coherent value proposition as well as fear of losing competitive advantage or revealing trade secrets. The lack of alignment in objectives undermines the understanding of the potential benefits and incentive for collaboration. Consequently, the synergies remain largely untapped, obstructing collaborative approaches.

# 6. DISCUSSION AND CONCLUSION

The final chapter concludes the theoretical and practical contributions of the study. Sub-chapter 6.1 discusses the key findings and observes them in light of the existing literature. Sub-chapter 6.2 focuses on the practical implications of the study. Sub-chapter 6.3 discusses the quality and limitations of the study, providing critical reflections on the research process and outcomes. Finally, sub-chapter 6.4 presents suggestions for future research.

## 6.1 Key Findings

This study adopted a dual focus, simultaneously examining both circular economy and innovation ecosystems, aiming to investigate the synergies between these two concepts. The successful development of the circular economy park is shaped by both circular economy and innovation ecosystem perspectives. Following Grünbaum's (2007) conceptual framework of case studies, the innovation ecosystem is considered as the inner case nest and the circular economy is viewed as the outer case nest to gain a deeper understanding of the interplay between the inner and outer case nests, and consequently, reveal potential synergies. The aim was to examine the drivers that catalyse the circular economy transition and innovation ecosystem emergence, and barriers that hinder or obstruct them. To achieve the objectives, the study was guided by three main research questions. The first research question was: *What are the primary driving and inhibiting factors impacting the transition towards circular economy in waste management?* To answer the first research question, a framework of factors impacting the circular economy was created and identified drivers and barriers were categorised into five sub-categories, namely (1) economic, (2) environmental, (3) institutional and regulatory, (4) sociocultural, and (5) technological and information-related factors. The second research question was: *What are the driving factors that advance the emergence of an innovation ecosystem, and what are the factors inhibiting or obstructing it?* In response to the second research question, the drivers were classified into five sub-categories, specifically (1) economic benefits, (2) development of shared infrastructure, (3) regulatory-driven collaboration, (4) inter-organisational dynamics, and (5) information sharing and material resource dynamics, and barriers were divided into four sub-categories, including (1) competition, (2) regulatory incompatibility, (3) lack of shared vision and commitment, and (4) lack of information sharing and shared platform. The sub-categories of a circular economy and innovation ecosystems reflect the unique challenges, distinct

objectives, and dynamics of the concepts, thus the distinct categorisation for drivers and barriers. Finally, the third research question: *How are the identified factors that impact the circular economy and innovation ecosystems interconnected?* highlights the intricate relationship between the CE and innovation ecosystems and how their interconnectedness shapes the development of the circular economy park.

In the introduction, the initial assertion is that circular economy parks inherently integrate circular economy principles with innovation ecosystems and this potential was reflected in the results. Building upon the observations made in this study, both circular economy and innovation ecosystems share some similar aspirations, such as resource efficiency, knowledge exchange, and creation of novel innovations. The successful implementation of both concepts necessitates a systemic change, compelling value proposition, fostering actors' understanding of value, actor commitment, and shifting mindsets from individualistic business practices to collaborative approaches, departing from conventional practices. Thus, based on the findings of the conducted study, it can be argued that the circular economy and innovation ecosystems are intricately linked, with the potential to bolster each other's objectives and drive transformative change.

The study's findings reveal that organisations measure the benefits of a circular economy and innovation ecosystems mainly in monetary value. De Silva et al. (2018) highlight the multi-dimensional nature of value, namely financial and non-financial types of value, where non-financial value comprises, among other things, knowledge, new forms of innovation, and collaborative relationships. Furthermore, companies often prioritise short-term gains, whilst these benefits require time to fully materialise. An acknowledged tension persists within companies wherein they desire tangible value but hesitate to invest before it materialises. This absence of investments inhibits the realisation of any meaningful value. Song et al. (2024) reported similar findings and noted that actors refrain from making specialised investments until they perceive the potential for collective value creation, yet, if many actors do not participate in ecosystem activities it will be impeded, slowing down the ecosystem emergence. Furthermore, market uncertainties can make it risky for participants to invest resources in the circular economy and innovation ecosystem activities.

The transition to a circular economy at its core is driven by environmental factors, which ultimately have a significant impact on other categories, mainly regulatory factors through which it influences economic and sociocultural factors. Environmental challenges require urgent actions and a systemic change, driving the transition to a more sustainable circular economy. Regulatory drivers are significant in the shift from a linear to circular econ-

omy. By tightening regulations regarding sustainability, taxes, and environmental permits, companies are incentivised to increasingly adopt circular practices. In line with previous literature (e.g., De Jesus & Mendonça, 2018), a comprehensive policy mix would efficiently promote the circular economy. The most significant economic driver is the affordability of circular economy practices, yet many current circular solutions remain out of reach. Sociocultural drivers, including growing awareness and demand for circular practices among both companies and customers significantly enhance the transition to a circular economy. The availability of diverse materials provides a wide range of opportunities in the circular economy, for instance, to reuse and repurpose materials. The modern technology plays a critical role in developing new ways to process waste as well as gather and analyse circular economy data to understand and maximise the benefits of the circular economy, which were identified as significant technological and information-related drivers.

The transition to a circular economy is affected by several barriers at different levels and categories. Economically, high initial investment costs with rapid changes in the market deter organisations from adopting circular economy practices. Additionally, profit motives guide decision-making in businesses, often at the expense of environmental considerations, which aligns with Tura et al.'s (2019) findings identifying that economic indicators are dominant in decision-making. Salmenperä et al. (2021) noted that if different departments fail to commit to circular economy targets, it could impede progress towards the circular economy. In a similar vein, this study revealed that while companies had successfully integrated circular economy into their strategies, individual branches exhibited varying levels of integration. While certain companies demonstrated robust circular economy strategies, the role of circular economy practices in Peittoo remained notably weaker. The lack of viable market for circular economy practices poses challenges for waste management companies seeking to transition to a CE. From regulatory perspective, the national legislation tends to focus on short-term needs over long-term effects, making the market more unpredictable and riskier to invest in circular practices. Insufficient promotion of waste-based materials creates a regulatory barrier, often resulting in higher prices compared to virgin raw materials. This finding is corroborated by several scholars (e.g., Kirchherr et al., 2018; Ranta et al., 2017; Grafström & Aasma, 2021) where low virgin raw material prices are viewed to drastically hinder the adoption of circular solutions. Sociocultural barriers significantly hinder the transition to a circular economy as the slowly changing industry and resistance to change from both companies and customers complicate the process. Kirchherr et al. (2018) state that low prices of virgin raw materials are the root cause for sociocultural barriers, which is also reflected in this

study's findings; businesses hesitate to renew their practices because linear approaches appear more cost-effective, and customers are unwilling to pay more for circular products and sustainable practices. Similarly, Tura et al. (2019) discovered that customers are reluctant to pay more for waste-based materials, which can be attributed to Ranta et al.'s (2017) finding that customers tend to favour new products over reused ones.

The current environmental permit application process is incompatible with the innovative nature of the circular economy discouraging the innovativeness of waste management companies. Environmental barriers remain largely unacknowledged in existing scholarly works compared to other sub-categories. The presence of hazardous materials and components makes the transition to a circular economy more challenging for waste management companies, posing challenges to the processing of these hazardous substances. In line with the existing literature, the lack of competitive technology is a significant technological and information-related barrier. Some technologies for certain processes do not process materials efficiently creating significant costs. Furthermore, processing of materials may burden the environment by shifting emissions from one part of the process to another, making it unsustainable. In contrast to previous literature, which highlighted the lack of waste stream data (Kirchherr et al., 2018) and lack of IT systems measuring and monitoring the transition to a circular economy (Grafström & Aasma, 2021) as barriers to achieving circularity, this study revealed that waste management companies possess considerable amount of material stream data due to annual reporting to ELY Centre but fail to utilise it effectively in their own operations.

Based on this study, the dialogue between waste management companies and waste producers is close to non-existent when it comes to waste prevention. The notion here is that in the process of creating a product, waste management companies are not typically involved in the development process, leading to missed opportunities in integrating waste reduction measures into the lifecycle of the product. The lack of communication and collaboration between waste management companies and product designers may negatively impact the opportunities to reuse the materials later in the product lifecycle. From the initial design phase, products need to be designed with circular economy principles as a fundamental part of the process, as mentioned by Govindan and Hasanagic (2018).

In the context of the Peittoo circular economy park, the emerging innovation ecosystem faced formidable barriers that ultimately obstructed its emergence, or alternatively, the driving forces were insufficient to catalyse the formation. The most significant barriers that stifled the emergence of the ecosystem begin with a lack of shared vision and goals, and therefore, not understanding the value of ecosystem activities and participation.

These barriers manifested in actors' reluctance to collaborate, drive change, and share information, creating another layer of barriers. All the previously mentioned barriers can, for the most part, stem from a lack of orchestrator who would play a crucial role in facilitating communication and aligning the interests and activities within the ecosystem. Echoing the research of Dedehayir et al. (2018), the orchestrator is indispensable for the emergence of an innovation ecosystem. However, the orchestrator alone cannot bring the ecosystem into existence if actors keep failing to recognise the value of ecosystem activities and are hesitant to participate in them.

The most significant drivers to the innovation ecosystem emergence were identified to be the economic viability and value considerations. Naturally, for-profit organisations aim to gain profit from their operations and seek to capture and create value. However, at this stage, no value proposition was created, which Adner (2017, p. 43) defines to be the foundation of the ecosystem. Other key drivers to collaboration arise from legislation, more specifically mandates outlined in environmental permits, is seen to set a groundwork for ecosystem activities. Simultaneously, the existing collaboration lays a foundation for trust which is identified as a key element for a successful innovation ecosystem in this study. Despite the expressed interest in collaboration and information exchange, none of the actors demonstrated readiness or willingness to take initiative. The identified driving factors were not holistic, but rather focused on narrower collaborative opportunities. The driving forces were unable to surmount the prevailing barriers regarding the emergence.

This study underscores that a value proposition is critical for the emergence of the ecosystem. Without a compelling value proposition, innovation ecosystems are prone to failure, as exemplified in this case study. Additionally, the ecosystem emergence should start with a critical problem or requirement that participants need to be addressed. The objective needs to be important to the participants for them to recognise the value in ecosystem activities and commit to them. These findings align with Adner's (2017) ecosystem concept, which posits that ecosystems begin with a value proposition and involve recognising where ecosystems are relevant.

All in all, the circular economy park's development is influenced by the factors that affect the circular economy (outer case nest) and those related to the innovation ecosystem (inner case nest). Peittoo's original purpose was to serve as a final disposal site, but eventually, it was repurposed into a circular economy park. Based on the study's findings, it is evident that the site is still in the process of transforming into a circular economy park. The key issue behind the Peittoo circular economy park is that the incumbent actors began their operations before the transition to a circular economy park, which means

that all the actors must adjust their company-level strategies to align with the park's joint vision. Likewise, this is recognised by Zhu et al. (2015) who found that most eco-industrial parks face challenges in successfully achieving operational implementation, particularly those initially established as standard industrial parks.

As found in this study, the lack of synergies between the operators was detrimental to the activities of the circular economy park. Thus, there must be actors that can complement each other and benefit from collaborative activities in a manner that surpasses the value achievable individually. In fostering synergies among incumbent actors, the entry of new circular economy companies is considered pivotal. A successful implementation of circular economy and functional innovation ecosystem necessitate systemic change, both being an outcome of several companies that collaborate with each other, emphasising the need for cross-industrial collaboration. As noted in the theoretical framework, innovation ecosystems carry the potential to foster collaboration, which circular economy necessitates. A key driver for this collaboration is the long-term economic viability, which is critical in both circular economy and innovation ecosystem activities.

The location of the circular economy park is a significant challenge, which causes substantial costs in logistics and poses a barrier for the growth of the circular economy park. However, the key idea of the circular economy park is to share resources, such as information and materials, so that the costs of transportation and waste handling could be minimised. Another considerable barrier to a circular economy and an emerging innovation ecosystem is the individuals' tendency to focus on company-level operations rather than ecosystem-level activities. This tendency coupled with the absence of well-established trust poses challenges to the central concepts of the circular economy park.

The emergence of an innovation ecosystem is highly shaped by the collaborative efforts and dynamics of various stakeholders, emphasising knowledge sharing and value co-creation. The transition to a circular economy involves shifting away from the traditional linear model, drawing attention to collaboration across industries, innovation, and systemic change. Innovation ecosystem emergence barriers stem from inter-organisational dynamics, such as fierce competition, lack of trust, and absence of an orchestrator while the key circular economy transition barriers are linked to broader forces, such as market considerations, legislation, and consumer behaviour. In the context of a circular economy park, innovation ecosystems mainly focus on the internal dynamics, such as the collaborative relationships between companies and other stakeholders operating within the park or in close proximity, and the circular economy concept emphasises the external dynamics of the park, such as suppliers, customers, and regulators. As the barriers are interdependent, overcoming them in isolation may result in fragmented and inadvertent

outcomes. Overcoming both sets of barriers simultaneously enables a holistic approach, reinforcing each other, however, prioritisation is required. In the future research avenues, this is discussed in greater detail.

## 6.2 Practical Implications

The study has several practical implications for managers and stakeholders to develop a well-functioning innovation ecosystem focused on a circular economy as well as policymakers to support the process. The findings of the study provide valuable implications on understanding and identifying the complex nature of barriers in both circular economy transition and emergence of innovation ecosystems. By delineating the drivers and barriers, it is possible to gain insights into why these processes might fail and how to ensure their successful realisation. Drivers and barriers vary in significance, with some being more critical than others. Some barriers significantly impede the progress and need to be addressed in order to overcome them, while other barriers are less influential with slight hindrances that may not hold the key priority. Similarly, some drivers serve as foundational elements for these processes, and their absence could drastically hinder or obstruct the progress.

This study demonstrates that the ecosystem perspective carries a compelling potential in transitioning to a sustainable circular economy. Circular economy parks offer a great platform to promote circular economy where environmental, social, and economic benefits are generated. A well-planned and established circular economy park itself is a significant driver for both circular economy and innovation ecosystems, bringing together companies from different industries, fostering collaborative initiatives and innovative circular solutions. As Finland is aiming to become a pioneer in the circular economy (SITRA, 2016), new circular initiatives need to be actively implemented. Amongst them are dedicated circular economy parks, however, reaching a point where they are fully functional is challenging.

In a circular economy, the core idea is to rethink entire value chains, processes, and consumption patterns. As circular economy goes beyond individual products and services, the entire system needs to be considered. A comprehensive approach to the circular economy is essential because while some solutions effectively combat climate change, they may not adequately support biodiversity actions. Without a holistic view, emissions may be inadvertently shifted from one part of the system to another. For instance, some recycling or repurposing processes generate significant emissions due to fossil fuels. Innovation ecosystems typically address complex challenges, which call for a systemic perspective and deep understanding of interconnected factors. To tackle the

pressing environmental crises on hand, lasting changes are required. These changes necessitate a transition from individualistic approach to collaborative business practices as well as regulations setting the framework for businesses to adopt sustainable practices, driving a systemic change. Thus, the first practical implication is directed towards policymakers:

1. More efficient and forward-thinking legislation is needed to support sustainable circular economy, inter-organisational collaboration, and innovation.

While climate change mitigation policies and laws have increased across different sectors, the policy coverage is limited for emissions from industrial materials (IPCC, 2023, p. 52). An individual policy instrument is not sufficient to address the complex challenges, but a coherent mix of policies that holistically targets the multi-faceted aspects of transitioning to a circular economy must be developed (Wilts & O'Brien, 2019). The current legislation in Finland seems to overly emphasise recycling over other circular practices, such as reuse and waste prevention (Ranta et al., 2018; Salmenperä et al., 2021). This trend is reflected in the operations of waste management companies where a circular economy is mainly promoted through recycling instead of pursuing a more systemic approach to a circular economy. Legislation must incentivise environmentally sustainable practices to foster the circular economy, for instance, through tax benefits and stricter regulations on waste management. Sweden aims to minimise the use of virgin raw materials by providing tax relief for reuse and repair through reducing VAT (Value-Added Tax) on circular products and services (Hartley, Van Santen & Kirchherr, 2020) with potential benefits worth investigating whether Finland should adopt a similar approach. Introduction of a raw material resource tax may be beneficial as well to drive companies to replace the use of virgin raw materials with waste-based alternatives. Legislation should, furthermore, encourage collaboration across industries and promote the exchange of resources and knowledge to enhance innovation. As found in this study, circular economy practices are not standardised, making it difficult for companies to implement and measure them. Thus, developing consistent guidelines and enhancing the collaboration between the private and public sector would be beneficial, and would respond to the companies' request for support from the public sector.

All these previously mentioned aspects, inter-organisation collaboration, innovation, and sharing of resources are integral to innovation ecosystems, which in turn introduces the practical implication targeting ecosystem participants, thereby suggesting:

2. Ecosystem participants must collaborate and mutually adjust the ecosystem value proposition while recognising the importance of individual value. Ecosystem actors need to balance the interests of different actors and ensure equal involvement and value for all participants.

The study's findings revealed that the most significant driver for the emergence of an innovation ecosystem is the value realised from ecosystem activities. This identified value encompasses economic benefits derived from innovation, knowledge sharing, and material exchange. While the participants of the study primarily emphasised the economic benefits, innovation ecosystems offer value beyond economic gains, including enhanced collaboration and sustainability practices. As actors may have differencing views on the value proposition, participants must collaboratively adjust the ecosystem value proposition to balance the interests of various actors. Without a relevant ecosystem-level value proposition, participation in ecosystem activities may seem unappealing and likely fails to emerge. The tension between ecosystem value and individual value can additionally cause the ecosystem to struggle with the emergence. With actors effectively communicating with each other, the participants can share their needs and expectations, and align their goals. This way, the ecosystem is more likely to achieve equal involvement and value.

3. A well-functioning innovation ecosystem requires the participation of various stakeholders that are willing to commit to ecosystem activities and that complement each other to find valuable synergies and are open to share information and resources.

For an innovation ecosystem to become successful and well-functioning, and to realise value from ecosystem activities, may take years. This requires long-term commitment from participants, which may be reached with transparency and trust as well as understanding the benefits of innovation ecosystem activities. Transparency and trust are cornerstones for ecosystem activities that require frequent interactions and communication among ecosystem actors. In order to share information and resources, companies need to have developed trust to some level. One of the most significant barriers to the emergence of an innovation ecosystem in Peittoo is the lack of heterogenous actors, leading to overly similar operational activities in which balancing coopetition and finding synergies is highly improbable. To tackle these challenges and support the complex emergence process, an orchestrator is essential, and therefore, the fourth practical implication is directed to the ecosystem orchestrator:

4. The role of an orchestrator in the emergence of an innovation ecosystem is critical, including the coordination of activities, aligning the goals of ecosystem participants, and assisting with the establishment of a shared vision. Additionally, the orchestrator plays a central role in overcoming the barriers that the innovation ecosystem faces.

Without an ecosystem orchestrator the development of an innovation ecosystem may be slow or non-existent, and the emergence may fail completely. A report conducted in 2014 by Ramboll demonstrates that the development of the circular economy park is nearly non-existent, and no major changes have occurred since its publication. As shown in this study, there are many barriers contributing to this, but the most significant appears to be the lack of an orchestrator. The orchestrator could either be publicly driven, such as the city, or company-driven, depending on the specific needs and desired outcomes of the ecosystem. Together with the ecosystem actors the orchestrator creates a shared vision and coordinates the ecosystem activities. As some barriers are fatal to the emerging ecosystem, the orchestrator must find ways to overcome them collaboratively with the ecosystem participants. While the orchestrator is essential throughout the emergence process, their responsibilities likely evolve as the ecosystem progresses through different stages. The role of the orchestrator is critical, especially during the birth phase of the ecosystem when foundational structures and relationships are established, whereas later on, they need to focus on sustaining the ecosystem.

## 6.3 Quality and Limitations of the Study

Given the expansive nature of both circular economy and innovation ecosystems, the study successfully provided a comprehensive overview and categorisation of the drivers and barriers, explored the complexity of these concepts, and demonstrated how they are interlinked. The embedded case study approach provided a more nuanced understanding by drawing insights from diverse subunits, thereby enhancing the reliability of the findings. The approach was particularly suitable for addressing the multi-level nature of drivers and barriers, as well as navigating these complex concepts. Although the study provided a detailed perspective on the circular economy and innovation ecosystems within a specific context, a circular economy park in Finland, it lacks international level considerations and comparative insights at the national level that a multiple case study might have offered. However, findings of prior research on circular economy drivers and barriers are mostly consistent with this study's findings. Similarly, it seems likely that other nascent innovation ecosystems encounter similar challenges to the one studied.

As an embedded case study and qualitative research typically imply, the findings of the study may not necessarily be generalisable. Some findings are highly context-specific, especially the legislation that regulates the use of waste and industrial by-products, which may result in region-specific circular economy opportunities and solutions. Due to a relatively small sample size, all drivers and barriers were not necessarily identified. Additionally, personal views of the participants may introduce bias into the data. However, the inclusion of several subunits can enhance the trustworthiness and depth of the insights gained compared to a single case study. As the interview questions were adjusted for each participant, the semi-structured interviews provided a broad range of perspectives. To ensure an accurate representation of the interview data, secondary data sources and group discussions were utilised.

As mentioned previously, defining the boundaries of an innovation ecosystem may be challenging. When the ecosystem has not yet emerged, this task becomes even more difficult, as demonstrated in this study. While interviews were conducted with circular economy park actors, crucial public actors, and consultants, other potentially beneficial actors for ecosystem activities were not necessarily identified. As the ecosystem has not yet emerged, data availability was limited, and therefore, obtaining relevant secondary data sources was proved to be challenging.

Finally, analysing the data and drawing conclusions are highly subjective processes, influenced by the researcher's understanding and interpretation of the data, which may result in human error. As discussed in sub-chapter 4.5, both investigator triangulation and data triangulation were used to minimise the risk associated with researcher error and researcher bias. Moreover, the categorisations for drivers and barriers may have some limitations. Firstly, the identified factors are interconnected and multifaceted, and one barrier may give rise to other barriers as discussed. Secondly, the categorisation of innovation ecosystem emergence factors is created by the researcher, following the researcher's conceptual understanding, as academic scholars have not provided an extensive categorisation. The framework of factors impacting the circular economy transition was built on and modified based on the existing literature, although it was influenced by the researcher's own perspective. This researcher bias is, however, reduced by the abductive research approach as the researcher moved back and forth between empirical findings and theoretical concepts to create the most suitable frameworks.

## 6.4 Future Research Avenues

Future research avenues arise from empirical findings of the study, its limitations, and insights drawn from prior literature. There is a dearth of empirical research in both circular

economy and innovation ecosystems as discussed before, and more research is needed to examine the synergies of these two concepts. The term circular economy park is infrequently cited in academic publications, and the differentiation between circular economy parks and other eco parks, such as eco-industrial parks, remains ambiguous. Therefore, future studies ought to focus on clarifying the distinctions between them and examine where they overlap.

Factors impacting the transition to the circular economy and emergence of innovation ecosystems were broadly examined. To investigate the generalisability of the study, future research should encompass multiple case studies conducted in different countries. Additionally, to reach a systemic change, the future research should investigate whether overcoming innovation ecosystem barriers, circular economy barriers, or both simultaneously is more critical, and prioritise accordingly. Based on this study, circular economy parks integrate elements of innovation ecosystems as well as circular economy, which however, does not seem to have existing discussion in academic literature, is calling for more research. Future research could assess the development of the circular economy park through critical factors that are considered as fundamental requirements for a circular economy park to become successful and specify which essential elements must be in place.

The empirical studies on circular economy drivers and barriers are still scarce, and few studies have specifically focused on these factors in waste management during the transition (e.g., Salmenperä et al., 2021). As the focus of circularity in waste management has not been on waste prevention, future research should shift their focus towards waste prevention measures and strategies. While acknowledging the multifaceted and interlinked nature of transition-related factors, each individual factor was categorised accordingly within the framework to clarify the already complex concept. The findings of the study connotate that the barriers develop an intricate network of multifaceted challenges, explaining why these barriers are so difficult to overcome. Joint efforts and strategies to overcome the complex barriers are recommended to be investigated further. Moreover, additional research to comprehensively assess the environmental impacts of the circular economy is needed.

As innovation ecosystem literature lacks empirical studies on the emergence and the factors that facilitate and inhibit the emergence process, this study aimed to shed light on these crucial aspects. Most studies explore the development of innovation ecosystem activities after a successful emergence, adopting an ex-post view (Pushpananthan & Elmquist, 2022); thus, this study applied a proactive approach by investigating the phenomenon before the emergence. There is a need to carry out longitudinal studies to track

the emergence process and developments of innovation ecosystems over time, offering valuable insights on how ecosystems emerge. While it was recognised that drivers and barriers are interconnected and vary in significance, the study does not answer to what extent certain factors are fatal, and whether they are fatal in other contexts. Future studies could further explore the drivers and barriers identified in this study to understand the significance of each factor by conducting a quantitative study.

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# APPENDIX A: INTERVIEW GUIDES

**WASTE MANAGEMENT COMPANY INTERVIEWS**

***1. Introduction***

Could you share a brief overview of your background?

Could you describe your role and responsibilities within the company?

***2. Current situation – Material streams and information flows***

What materials are processed?

What are the most significant materials to the company?

Where do the materials come from, and who are the customers?

What are the phases in material processing on a general level?

Are there any collaborative efforts among companies for material processing?

Are there shared infrastructure/services with other operators in the area?

What (non-public) data is shared with other operators?

How is the joint monitoring of water quality carried out in practice?

***3. Value Creation***

***New and existing value chains***

Do you already have material flows out of the Peittoo area (i.e., reuse of waste)?

If so, which actors are involved?

What effects does this have on the processing of the material?

What kinds of permit procedures were needed to enable such an activity?

What kinds of circular economy opportunities do you see for the materials collected in the Peittoo area?

Are there already (downstream) users for these material flows? How do permit processes affect the further processing and development of materials?

Why have not the potential opportunities been taken up yet? What are the factors that prevent the implementation of such a business?

**Collaboration and its value potential**

Is there co-innovation with the operators of the area (RDI, services, etc.)?

What kind of collaboration between the operators of Peittoo would be useful to facilitate co-innovation?

What could such collaboration look like in practice? Who takes responsibility for what? Does someone need a leading role?

What is needed for the benefits of such collaboration to be realised?

What are the most significant changes to the current situation?

What kind of economic effects does such a change have? Costs? Schedule? New or increased value/turnover/business activities?

How should the benefits be shared among the operators? What if someone benefits or invests more than others?

How can all parties be motivated for this type of collaboration?

What motivates your company to collaborate?

***4. Environmental permit processes***

***Challenges experienced during the permit process***

Describe the challenges relevant to you in the most recent environmental permit application process.

How did the process go overall?

What phases took the longest?

Which phases required the most effort?

What could the existing documentation be used for, and what aspects needed new documentation?

How does the authority-company collaboration work?

***5. Closing***

What factors above are the most important for collaboration?

Is there anything else you would like to share?

## AUTHORITY INTERVIEWS

### A) ENVIRONMENTAL PERMIT AUTHORITY

#### *1. Introduction*

Could you share a brief overview of your background?

Could you describe your role and responsibilities in the application process of environmental permits?

#### *2. Environmental permits*

As an example of an environmental permit granted to a company in Peittoo.

- What are the stages of the permit process?
- Who participated in the permit process from the authority and applicant?
- What statements were needed, and how were those who gave them selected?
- Were there any complaints or opinions?
- How were the decisions made?

How do environmental permit applications differ from each other?

In which matters should discretion be used and why?

What factors support or impede your own activities?

From the applicant's perspective, what factors facilitate or hinder progress?

What possible challenges does the innovation activity cause for environmental permit application processes?

#### *3. Closing*

Is there anything else you would like to add?

### B) SUPERVISORY AUTHORITY

#### *1. Introduction*

Could you share a brief overview of your background?

Could you describe your role and responsibilities in monitoring the environmental permit?

***2. Monitoring environmental permits***

How is the monitoring of environmental permits carried out in practice? (An example of an environmental permit granted to a company in Peittoo).

Who participated in monitoring from the supervisory authority and the applicant?

What kind of monitoring is carried out?

What is included in the reporting?

How do these cases differ from each other?

In which matters should discretion be used and why?

What factors support or impede your own activities?

From the applicant's perspective, what factors facilitate or hinder progress?

What possible challenges does the innovation activity cause for monitoring?

***3. Environmental impact assessment (EIA)***

What is your role in the environmental impact assessment process?

How is the environmental impact assessment carried out in practice? (An example of the EIA conducted for a company in Peittoo).

What are the stages of the process?

Who participated in the process from the authority and applicant?

What statements were needed, and how were those who gave them selected?

How do the EIAs differ from each other?

In which matters should discretion be used and why?

What possible challenges do the innovation activities pose for the EIA process?

***4. Closing***

Is there anything else you would like to add?

**CONSULTANT INTERVIEWS**

***1. Introduction***

Could you share a brief overview of your background?

Could you describe your role and responsibilities in the environmental permit applications?

In addition to the environmental permit applications, are you responsible for monitoring as well?

***2. Environmental permits***

From the point of view of your role, what are the phases of permit applications?

- How does the process progress as a whole?
- What stages last the longest?
- Which steps cause the most work?

What can the existing documentation be used for and what does new documentation need to be created for?

Do you use some kind of environmental permit application template for applications?

How do the environmental permits differ from each other?

What challenges are there regarding the environmental permit application process?

What works well with the environmental permit application process?

How does the communication work in practice (who is in contact with whom: are the companies only in contact with the authorities or are you in contact with them too)?

- How does collaboration with companies work?
- How does collaboration with authorities work?

What factors support or impede your own activities?

What kind of collaboration between companies could there be in the environmental permit application process? (sharing information, etc.)

- What currently prevents the collaboration?
- What could enable collaboration?

Based on previous interviews held, it seems that the permit decisions differ from each other. What factors affect this?

***3. The future of environmental permits***

How could permit decisions be unified?

What would make the process smoother?

How would the merging of AVI and ELY (one national agency) change the process?

How has the environmental permit application process changed / is it changing over time?

***4. Closing***

Is there anything else you would like to add?