

EXPLORING THE CIRCULAR ECONOMY POTENTIAL FOR ENHANCING
ENVIRONMENTAL SUSTAINABILITY WITH ECO-INNOVATION FRAMEWORK
INTEGRATION TO OVERCOME BUSINESS MODEL BARRIERS

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Dedication

With deepest love and gratitude, I dedicate this thesis to my family, who have walked this path alongside me. Your collective love and encouragement have been invaluable throughout this journey.

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This doctoral journey would not have been possible without the unwavering guidance and profound insights of my mentor. Your advice was not merely directional; it was a compass, consistently pointing me toward clarity and excellence. Your belief in my potential, even when I doubted myself, fueled my perseverance and ultimately brought me to this milestone.

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My sincere appreciation extends to the organizations I am affiliated with, whose assistance and opportunities were instrumental in the completion of this work. The practical knowledge and unwavering support I received from these collaborations have been invaluable.

Finally, and most importantly, I offer my deepest love and gratitude to my family. Your unwavering love, boundless patience, and countless sacrifices have been the foundation upon which this achievement was built.

I am eternally grateful to my beloved brother (Martyr) for his unwavering faith in me, which allowed me to pursue this dream.

ABSTRACT

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Pallavi Sachan

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This thesis investigates the co-operative potential of integrating an eco-innovation framework with circular economy principles overcoming the circular business model barriers. This is done with a hypothesis that eco-innovation integration with circular economy will advance environmental sustainability across diverse organizational and geographical contexts. While attempting this study, I started by recognizing the limitations of the linear economic model as well as circular economic model and the imperative for sustainable business practices should start with innovation not just the strategy alone, hence this thesis explores the challenges and opportunities associated with implementing circular economy first. For this, I collected secondary data on exploring the potential for eco-innovation integration with circular economy, followed by analysis on multiple case studies (across six continents namely Africa, Asia, Europe, Latin America, North America, and Oceania) to identify critical barriers hindering effective circular economy implementation. The study then examines how an eco-innovation framework can be strategically leveraged to overcome these barriers and drive enhanced environmental performance. Though, I was able to find 141 case studies from the literature (Ellen Macarthur Foundation), in this thesis, only 41 case studies (Africa - 6, Asia - 13, Europe -

5, Latin America - 7, North America - 7 , and Oceania – 3). In each case study, I first understood how the circular economy was implemented and explored the barriers, then based on the learnings from the previous research question on eco-innovation and circular economy potential strategies were explored followed by understanding on the eco-innovation enabled environmental sustainability through circular practices. This is repeated for each of the case study in selected geographical locations.

Findings reveal that successful implementation necessitates context-specific strategies, particularly when considering the distinct socio-economic conditions of the Global South versus the Global North. Furthermore, I assessed the business implications of adopting an integrated eco-innovation and circular economy approach, including impacts on financial performance, competitive advantage, and stakeholder engagement. Based on my observations, I concluded this thesis by providing key findings as a summary, which can be considered by organizations seeking to transition towards more sustainable business models. Lastly, I also explored limitations of this thesis, along with avenues for future research.

Key words: Circular Economy Implementation Barriers, Eco-Innovation Framework, Case Study Research, Circular Economy in Global North vs. Global South, Environmental Sustainability

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CHAPTER I

INTRODUCTION

“The traditional linear economic model, characterized by its 'take-make-dispose' approach” (Ellen MacArthur Foundation), has driven unprecedented production and consumption, placing immense strain on our planet's finite resources and ecosystems. This unsustainable model, marked by resource depletion, environmental degradation, and economic inefficiencies, necessitates a fundamental shift towards circular and sustainable economic systems. In this thesis I address this particular critical need by investigating the potential of integrating an eco-innovation framework with “circular economy principles to enhance environmental sustainability” (Ellen MacArthur Foundation) within organizations operating in diverse geographical contexts. The research recognizes that simply adopting circular economy strategies is not enough; “a more holistic and innovative approach is required to overcome the inherent barriers and unlock the full potential of circularity” (Ellen MacArthur Foundation). The overarching aim of this research is to provide a comprehensive understanding of the challenges and opportunities associated with implementing circular economy strategies and to identify how eco-innovation can be strategically leveraged to overcome these challenges and drive more sustainable outcomes.

In this thesis, I will take you on a journey exploring the linear economy's unsustainable path and the promising potential of integrating eco-innovation with circular economy principles in a more organized way and each of the topics explored are arranged systematically in coming sections under each chapter of the thesis. To give more about it on learning you can from this thesis, I take this summary approach on what we will delve into; we will delve into the heart of the 'take-make-dispose' model, uncovering its detrimental impacts on our planet's resources and the challenges it poses for organizations

striving for sustainability. Through a comprehensive analysis of real-world case studies spanning across continents, we'll dissect the barriers hindering the effective implementation of circular economy strategies and illuminate how eco-innovation can serve as a catalyst for transformative change. You'll gain insights into the critical success factors for fostering eco-innovation-driven circularity, particularly in the context of the Global South and the Global North followed by a thorough discussion and business implications and future research one can explore as an opportunity to further enhance this field.

1.1 Linear Economy

The prevailing global economic model has historically adhered to a linear paradigm, “characterized by a unidirectional flow of resources from extraction to production, consumption, and eventual disposal”. This "take, make, dispose" approach (see Figure 1.1), as succinctly summarized by the Rome Business School (2023), has been a dominant force in shaping economic activities for an extended period. In this system, “raw materials are extracted from the environment, transformed into manufactured goods, consumed by individuals and organizations, and ultimately discarded as waste, often ending up in landfills or incinerators” (Rome Business School, 2023). This linear process, while driving economic growth, places significant strain on natural resources and ecosystems, leading to a range of environmental and economic challenges. The inherent simplicity and apparent efficiency of the linear model have contributed to its widespread adoption, yet its long-term sustainability is increasingly called into question in the face of growing environmental concerns and resource scarcity (Rome Business School, 2023). Understanding the fundamental characteristics and limitations of the linear economy is crucial for appreciating the need for alternative, more sustainable economic models, such as the circular economy.

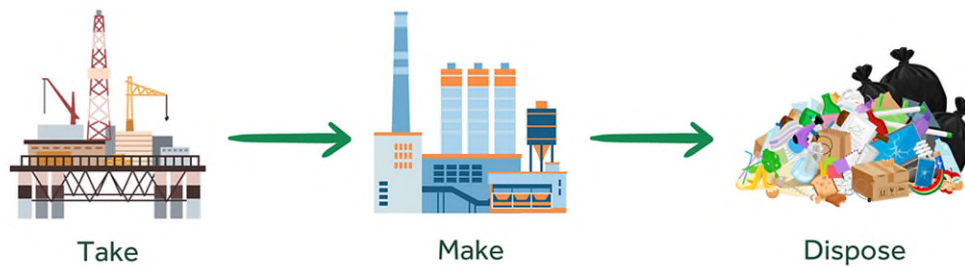


Figure 1.1. Take-Make-Dispose Linear Economy Model. Adopted from Circulayo Ltd.

1.2 Why is the Linear Economy not Sustainable? What it Means to Organizations?

The linear economy, characterized by its "take-make-dispose" model, is fundamentally unsustainable due to its inherent reliance on finite resources and its generation of substantial waste, leading to a cascade of negative environmental and economic consequences (Reconomy, 2025; Sustainability Directory, 2025). This model, while historically driving economic growth, now faces increasing scrutiny due to its detrimental impact on the planet and its long-term viability for organizations. As shown in Figure 1.2, the linear economic model's inherent unsustainability stems from its reliance on finite natural resources and its generation of substantial waste, leading to a cascade of negative environmental and economic consequences (Rome Business School, 2023). Resource depletion is a primary concern, as the linear model necessitates the continuous extraction of raw materials to fuel production, placing immense strain on ecosystems and biodiversity (Sustainability Directory, 2025). As demand for goods and services increases, the strain on these resources intensifies, jeopardizing the balance of ecosystems and biodiversity. Reconomy (2025) highlights that the world extracts over 100 billion tonnes of raw materials annually, with only a small fraction (6.9%) cycled back into the economy, underscoring the scale of resource depletion. Furthermore, the disposal phase of the linear economy contributes significantly to environmental pollution and degradation. Landfills, often overflowing with non-biodegradable waste, release harmful substances into the soil

and water, while incineration processes emit pollutants that exacerbate climate change and air quality issues (Rome Business School, 2023). The Sustainability Directory (2025) emphasizes that the linear economy accelerates entropy, transforming concentrated, high-quality resources into dispersed, low-quality waste, requiring significant energy input and generating substantial environmental degradation.



Figure 1.2. Resource flows over the life-cycle stages of product/service illustrating the unsustainable nature of linear economy business model. Source: Adopted from Wautelet, (2018).

For organizations, the linear economy presents a range of challenges and risks. Firstly, the increasing scarcity and rising costs of raw materials can impact profitability and competitiveness. It can be more considered as a resource costs and supply chain vulnerability issue; as said earlier, the increasing scarcity and rising costs of raw materials can impact profitability and competitiveness (Reconomy, 2025), it is hard for organization to make decisions on sourcing and there is high chance for compromising if the regulations are not strict enough in a given georgraphy where the organization is having its operations. To give a more generic example, how much resources are being consumed, the global ecological footprint suggests that humanity is consuming resources at 171% of Earth's capacity, creating supply chain risks, particularly for industries reliant on critical raw materials (Reconomy, 2025). Secondly, growing consumer awareness and regulatory pressures are pushing organizations to adopt more sustainable practices, creating reputational and operational challenges for those clinging to the linear model. Thirdly, the

linear economy's inherent inefficiencies, with valuable materials lost in the disposal process, represent a missed opportunity for organizations to capture value through resource conservation and reuse. Increased waste management and disposal costs also pose a significant challenge. As landfills reach capacity and governments impose stricter waste regulations, disposal costs rise worldwide, cutting into profits and reducing economic resilience (Reconomy, 2025). Moreover, the linear economy discards billions of pounds worth of valuable materials every year, representing a lost economic opportunity for organizations to capture value through resource conservation and reuse (Reconomy, 2025).

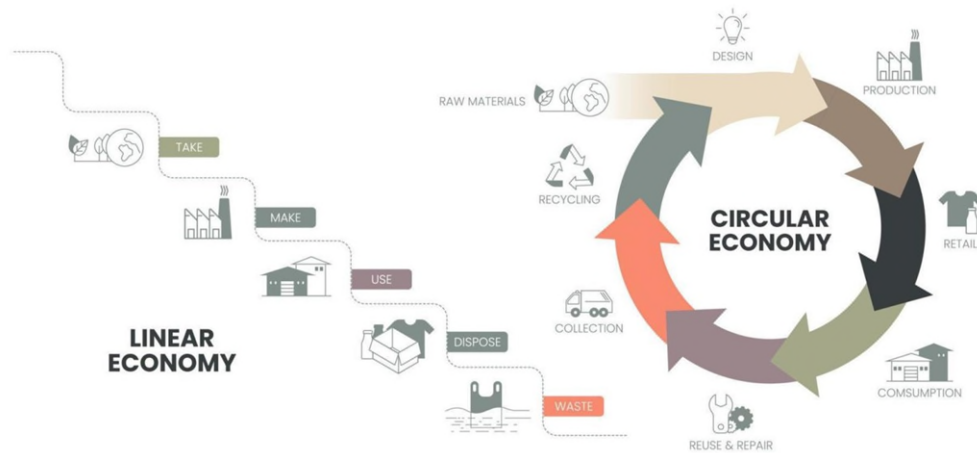


Figure 1.3. Understanding the business shift between the linear economy and circular economy considering the product/service life cycle. Source: Adopted from Egin

Learnings from Figure 1.3, the global community increasingly recognizes the limitations of the linear economy, organizations must proactively transition towards more circular and sustainable business models to mitigate risks, enhance resilience, and capitalize on emerging opportunities (Reconomy, 2025; Sustainability Directory, 2025; Rome Business School, 2023). The cost of inaction is clear: higher costs, wasted resources, environmental damage, and economic vulnerability (Reconomy, 2025; Sustainability Directory, 2025). Also, the environmental cleanup costs and regulatory pressure are

increasing, with governments worldwide introducing tougher environmental regulations to curb pollution and carbon emissions (Reconomy, 2025). Organizations “operating within a linear economy are increasingly liable for environmental damage, facing rising costs for carbon taxes, pollution fines, and regulatory compliance” (Reconomy, 2025).

1.3 What is Circular Economy?

The circular economy represents a paradigm shift from the traditional linear "take-make-dispose" model to a restorative and regenerative system where materials never become waste and nature is regenerated (Ellen MacArthur Foundation; Jørgensen & Pedersen, 2018). It is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution by decoupling economic activity from the consumption of finite resources (Ellen MacArthur Foundation).

“The Ellen MacArthur Foundation defines the circular economy as being based on three core principles”, all driven by design (Ellen MacArthur Foundation) (Figure 1.4):

- Principle-1 is eliminate waste and pollution, where designing out waste and pollution from the outset, rather than trying to manage them after they have been created.
- Principle-2 is “Circulate products and materials (at their highest value), where keeping products and materials in use for as long as possible through strategies like reuse, repair, refurbishment, remanufacturing, recycling, and composting” (Ellen MacArthur Foundation)
- Principle-3 is regenerate nature, where shifting from extraction to regeneration, restoring ecosystems and enhancing natural capital.

Jørgensen and Pedersen (2018) emphasize that circular-economic thinking is based on the idea of the economy being restorative and regenerative—that is, economic activities

should strengthen rather than break down social and environmental resources. “This entails maintaining products and materials in the economy at as high a quality as possible over time so that they can be reused many times” (Jørgensen and Pedersen, 2018). It's about creating a system that is both environmentally sustainable and economically viable, fostering innovation, creating new business opportunities, and building a more resilient and prosperous future for all (Ellen MacArthur Foundation; Jørgensen & Pedersen, 2018).

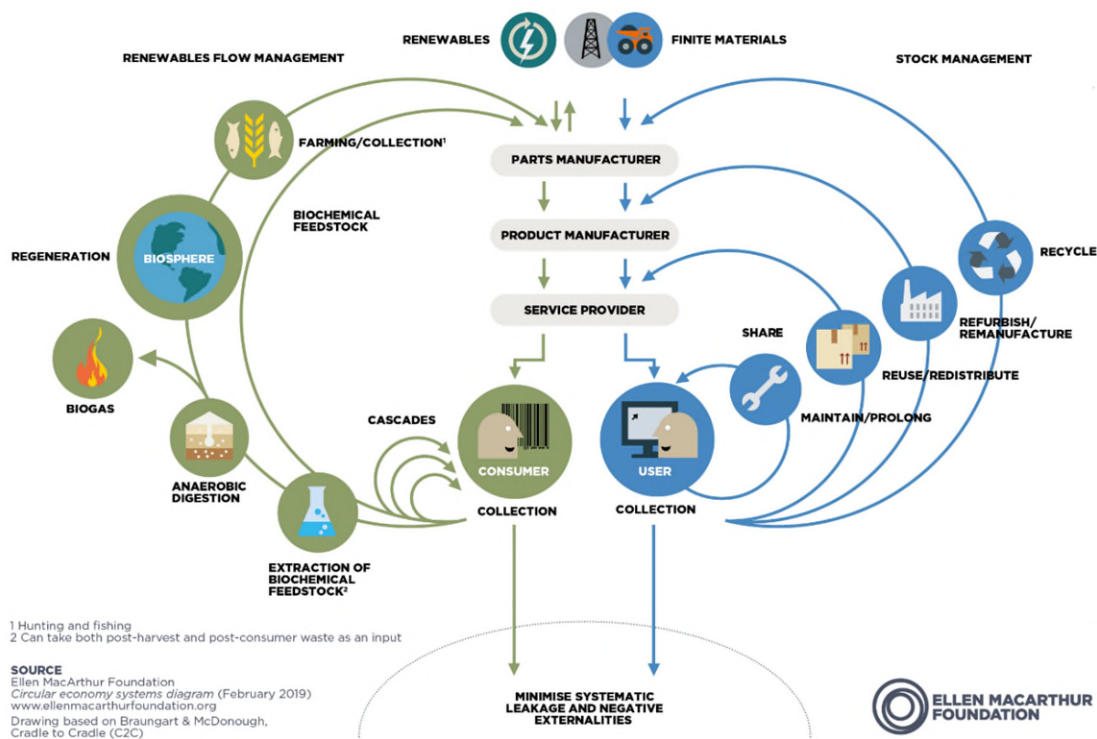


Figure 1.4. Natural and technical materials flow continuation in circular economy as per Ellen MacArthur Foundation. Source: Adopted from Ellen MacArthur Foundation

Additionally, when I looked at other sources of information especially the US EPA and European Commission databases, the circular economy is defined and understood in a consistent manner, emphasizing its role as a transformative alternative to the traditional linear models. Here's a synthesis of the key definitions given, US EPA defines a circular

economy as a system that "keeps materials and products in circulation for as long as possible." It involves "industrial processes and economic activities that are restorative or regenerative by design," enabling "resources to maintain their highest value for as long as possible," and aiming "for the elimination of waste through the superior design of materials, products, and systems (including business models)" (EPA; <https://thebftonline.com/2022/04/07/the-eus-pursuit-of-a-circular-economy/>); The European Commission describes the circular economy as a model where "products and materials are kept in circulation for as long as possible, and waste and resource use are minimised" (European Commission). It is presented as a crucial transition for "reducing pressure on natural resources, halting biodiversity loss, achieving climate neutrality by 2050, and building a more resilient and competitive Europe" (European Commission). In essence, the circular economy is a systems-focused approach that prioritizes resource efficiency, waste reduction, and the regeneration of natural systems. It represents a fundamental shift from the linear "take-make-dispose" model to a more sustainable and resilient economic system.

1.4 How Does Circular Economy Contribute to Environmental Sustainability?

The circular economy presents a powerful and multifaceted approach to achieving environmental sustainability, addressing critical challenges such as resource depletion, pollution, climate change, and biodiversity loss (Ellen MacArthur Foundation; Jørgensen & Pedersen, 2018; UNEP F). By shifting away from the linear "take-make-dispose" model, the circular economy creates a system that minimizes waste, maximizes resource utilization, and actively regenerates natural systems (Ellen MacArthur Foundation; UBE, 2025). Here are some key ways in which the circular economy contributes to environmental sustainability, drawing from the provided sources:

- **Reduced Greenhouse Gas Emissions:** A core benefit of the circular economy is its potential to significantly reduce greenhouse gas emissions (Kenniskaarten, 2024; UBE, 2025). By minimizing resource extraction, processing, and manufacturing, the circular economy tackles a major source of global emissions. (Kenniskaarten 2024) notes that 62% of global greenhouse gas emissions (excluding land use and forestry) come from these activities.
- **Resource Conservation and Reduced Raw Material Dependence:** The circular economy prioritizes reuse, repair, refurbishment, and recycling, thereby reducing the demand for virgin raw materials (UBE, 2025; European Parliament). This conserves finite resources, reduces landscape and habitat disruption, and mitigates the risks associated with supply chain vulnerabilities and import dependence (European Parliament).
- **Waste Reduction and Pollution Prevention:** By designing products for durability, repairability, and recyclability, the circular economy minimizes waste generation and prevents pollution (UBE, 2025; Ellen MacArthur Foundatio). This reduces the burden on landfills and incinerators, preventing soil and water contamination and reducing air pollution (UBE, 2025).
- **Ecosystem Regeneration and Vitality:** The circular economy promotes practices that maintain and restore vital ecosystems, such as soil, air, and water bodies (Kenniskaarten, 2024). By minimizing the extraction of resources and the dumping of toxins, the circular economy helps to ensure that these ecosystems remain resilient and productive, providing essential services such as clean water, fertile farmland, and pollination (Kenniskaarten, 2024).

- **Biodiversity Protection:** By reducing landscape and habitat disruption and promoting sustainable resource management, the circular economy helps to protect biodiversity and prevent biodiversity loss (European Parliament).
- **Reduced Pollution and Improved Human Health:** The circular economy's emphasis on minimizing waste and resource extraction leads to cleaner water and air, which can drastically reduce the number of premature deaths resulting from pollution (UBE, 2025).

The circular economy offers a holistic and integrated approach to environmental sustainability, addressing multiple challenges simultaneously and creating a more resilient and prosperous future for both people and the planet (Ellen MacArthur Foundation; UNEP FI). It is a vital strategy for achieving the UN Sustainable Development Goals, the Paris Climate Agreement, the Kunming-Montreal Global Biodiversity Framework, and the Global Framework on Chemicals (UNEP FI).

1.5 The Global Shift Towards Circularity

The circular economy is no longer a niche concept; it has evolved into a global imperative. A growing number of governments, businesses, and organizations worldwide are recognizing the limitations of the traditional linear economic model and embracing the circular economy as a pathway to sustainable development, economic resilience, and environmental stewardship. This global shift towards circularity is evident in the growing number of circular economy initiatives being implemented at international, regional, and national levels (Table 1.1). These initiatives demonstrate a collective commitment to building a more sustainable and resilient global economy.

Table 1.1. Key factors driving the global shift towards circularity

Criteria	Description how the factor is driving the circularity
Resource Scarcity	The increasing demand for raw materials, coupled with the depletion of natural resources, is creating a sense of urgency to adopt more resource-efficient economic models. The circular economy offers a solution by minimizing the need for virgin materials and maximizing the utilization of existing resources
Environmental Concerns	Growing awareness of the environmental impacts of the linear economy, including pollution, climate change, and biodiversity loss, is driving demand for more sustainable production and consumption patterns. The circular economy offers a way to decouple economic growth from environmental degradation.
Economic Opportunities	Businesses are increasingly recognizing the economic benefits of circular economy strategies, such as reduced costs, increased innovation, and new market opportunities. Circular business models can create value by extending product lifecycles, recovering valuable materials, and offering innovative services
Policy Support	Governments around the world are implementing policies and regulations to support the transition to a circular economy, including extended producer responsibility schemes, waste reduction targets, and incentives for circular innovation.

The map highlights a global landscape where certain nations are taking the lead in environmental performance, a crucial aspect of the global shift towards a circular economy. As the GreenMatch report, "The World's Greenest Countries," indicates, nations like Sweden, Denmark, and the United Kingdom are at the forefront, driven by robust environmental policies and a commitment to sustainable practices. The map reinforces this (see Figure 1.5), showcasing Norway's leadership in green transport and Switzerland's

perfect score in sanitation and drinking water indicators. These achievements, as detailed in the GreenMatch report, often stem from a holistic approach that encompasses climate policy, carbon emissions reduction, energy transition, and fostering a green society. By prioritizing these areas, these countries are not only improving their environmental performance but also paving the way for a more circular economy, where resources are used more efficiently and waste is minimized (see Table 1.2 for strategies).

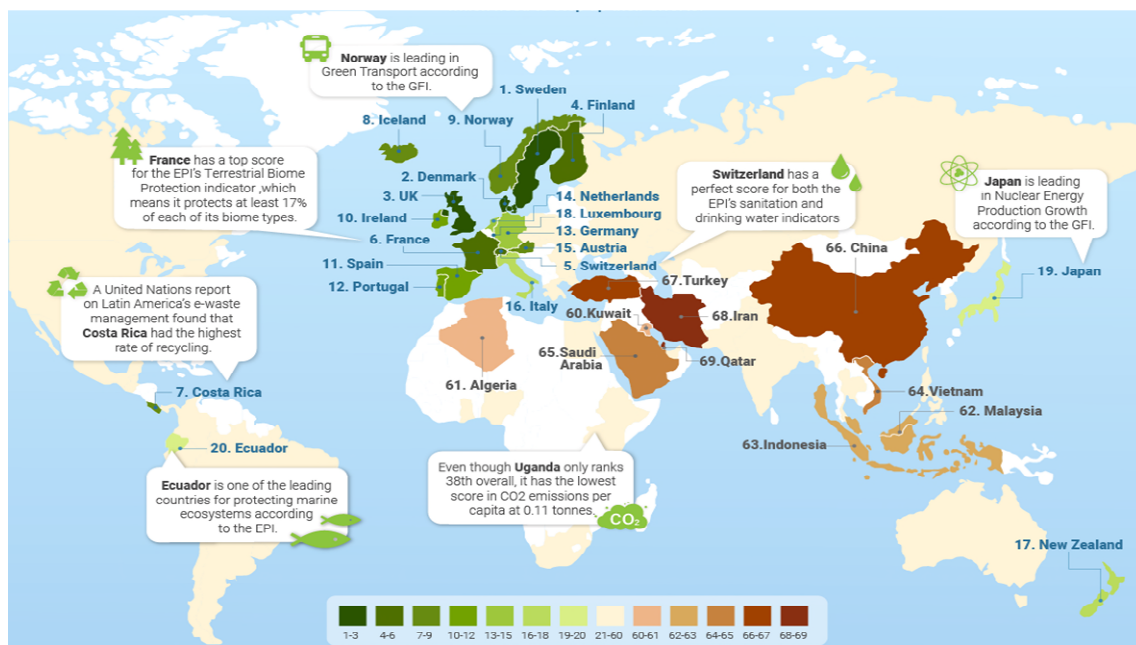


Figure 1.5. Worlds Greenest Countries. Source: Adopted from www.greenmatch.co.uk

Table 1.2. Country specific circular economy policy and legislation

Strategy	Country	Policy type	Theoretical Operation	Legislation	Source
Design & Production	France	Ecodesign & UPV		Loi AGECE (prohibition on the destruction of unsold stock)	EU Platform

				& repair index).	
	European Union	Recycled Content	Mandate a minimum percentage of recycled material in new products.	ESPR (Sustainable Products Requirements for the entire EU market).	
Reuse & Repair	Austria	Right to Repair	Forces manufacturers to make spare parts and repair information available.	Repair bonus (consumer receives a subsidy of up to €200 on repair costs).	EEA
	Sweden	Fiscal Incentives	Uses taxes to make repair cheaper than replacement.	VAT reduction on repair services for bicycles and clothing, among other things.	
Waste management	Belgium	Source separation & Diftar	Financial incentives for citizens producing less waste means paying less.	Diftar system (paying per kg of residual waste).	ICLEI

	South Korea	Recycling Mandates	Mandatory reuse of specific residual streams to minimize landfilling.	Mandatory food recycling (95% reuse as compost or energy).	WEF
Economic Systems	Netherlands	Circular Procurement	The government uses its purchasing power to stimulate the market for circular products.	National Circular Economy Programme (goal: 50% fewer primary raw materials in 2030).	PBL
	Japan	Product-as-a-Service	Encourages renting or leasing instead of ownership, so that the manufacturer remains the owner of the raw material.	Home Appliance Recycling Law (manufacturers responsible for raw material recovery).	OECD

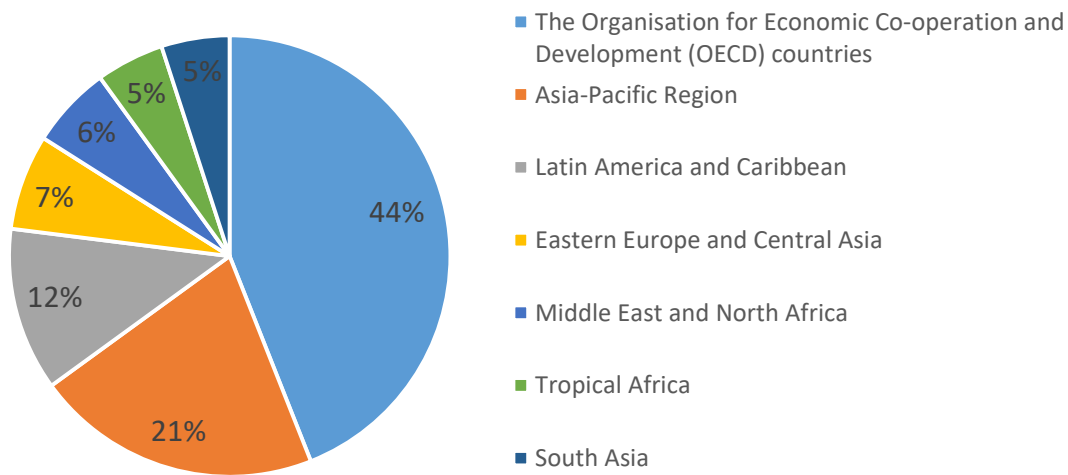


Figure 1.6. Waste production rates in different regions and the scope for circular economy. Source: Drawn based on the data obtained from Fedotkina et al., 2019

Seeing from Figure 1.6, the escalating global waste crisis is a significant driver behind the growing momentum towards circular economic models. A 2016 report, "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050," projects a substantial increase in worldwide annual waste generation, rising from 2.01 billion tons to an estimated 3.5 billion tons by mid-century (Kaza et al., 2018). This surge is anticipated to coincide with economic development, increased urbanization, and expanding populations across the globe. Data from the United Nations (UN) indicates a correlation between a nation's economic standing and its solid waste production. Generally, wealthier countries generate a higher volume of household waste per capita (Figure 1.6). However, in the European Union, elevated per capita waste levels are often accompanied by robust waste recycling initiatives. By 2025, waste generation rates USA (2.6 kg), the Netherlands (2.1 kg), New Zealand (3.6 kg), Norway (2.8 kg), and Switzerland (2.6 kg) (Kaza et al., 2018; Fedotkina et al., 2019).

Recognizing the opportunities presented by the waste crisis, public- and private-sector decision-makers worldwide are increasingly adopting policies aligned with the principles of the circular economy (CE) (Figure 1.7). However, these policies vary in their definitions of the CE and their approaches to its implementation (Preston et al., 2019). The CE fundamentally aims to expand the utilization of waste materials as secondary resources.



Figure 1.7. Global map showing the circular economy activity. Source: Adopted from Fedotkina et al., 2019

While the circular economy presents a compelling vision for a sustainable future, building a successful business within this framework is not without its challenges. As the World Economic Forum article "How to build a business in the circular economy" highlights (WEC, 2018), relying solely on customers' altruism is often a "route to failure" (Legge & Klett, 2017). The article emphasizes the importance of economic incentives in driving the circular economy. Tom Szaky, co-founder of TerraCycle, notes that while the concept of the circular economy can open doors for discussions, "the only motivator is money" for many stakeholders (Legge & Klett, 2017). Caring about the environment is

often a secondary consideration. The article identifies several key challenges in building a circular economy business:

- While consumers may express a willingness to be more environmentally friendly, they often hesitate to pay more for sustainable products.
- Producers often prioritize short-term profits and may perceive circular economy initiatives as sacrificing margins.
- New regulations can be seen as a risk, requiring expensive compliance or costly lobbying.
- The cost of collecting and processing waste must be less than the value of the recovered resources.

1.6 Barriers and Challenges in Circular Economy Implementation

Based on my observation in previous section, I explored the hurdles possible in circular economy implementation. I called these as barrier and challenges. The existing body of research on circular economy reveals a substantial amount of information concerning the obstacles and difficulties encountered during its implementation. It has been noted that "cooperation of external partners" and "partner restrictions" represent significant challenges, primarily due to a limited capacity to oversee circular business models. Consider, for example, the transition away from the traditional disposal-oriented approach to electrical and electronic equipment, where a clear understanding of each stakeholder or partner is essential. In this context, incentives could be offered to entities that effectively collect electrical waste from consumers. However, in practice, such cooperation between partners may be lacking (Kirchherr et al., 2017). Another challenge identified is "fashion changes" or "fashion vulnerability," as the success of circular economy initiatives can depend on the aesthetic appeal of Product-Component-Materials, the location of

remanufacturing facilities, circular Product-Component-Materials design, and modularity (Kirchherr et al., 2017). The issue of "capital tied up" is also a concern, as it introduces risks when financial transactions occur between stakeholders. For instance, if the infrastructure required for circular economy implementation is leased, the financial inflows and outflows must be shared among investors. Similarly, financial transactions between customers and producers can create a situation where capital is tied up. However, the risk of "capital tied up" can be mitigated by understanding customer types and their specific interests, as suggested in (Kirchherr et al., 2017; Bocken et al., 2017). "Customer type restriction" is identified as a challenge, as customers may not always be interested in remanufactured Product-Component-Materials (Jacobi et al., 2018). Additionally, "product category restrictions" have been reported as a challenge in another study (Ellen MacArthur, 2013). Remanufacturing "requires technological expertise" to redesign Product-Component-Materials to meet current customer demands and needs, which presents another obstacle to circular economy implementation (European Commission, 2011). "Operational risk" arising from the use of second- or lower-grade technical solutions is also a concern (European Commission, 2015). Numerous studies have highlighted "return flow challenges" in circular economy, focusing on the problems associated with return flows to investment and the difficulties in ensuring the "predictability and reliability of return flow" when planning circular economy solutions (European Commission, 2016). It has been suggested that the "return flow issue" can be resolved through closer relationships between stakeholders and customers (Ellen MacArthur, 2013, de Oliveira et al., 2018). In the early 20th century, the "Risk of Cannibalization" was identified as a potential challenge, where the introduction of circular business models could decrease sales compared to traditional linear business models (McDowall et al., 2017; Gregson et al., 2015). Other studies have emphasized the challenges posed by "lack of awareness" and "lack of support from related

policies, laws, and regulations," which can hinder the transition to circular economy (European Commission, 2011). Subsequent research has built upon these findings (Mathews and Tan, 2011). One study identified six key challenges facing circular economy: "complex international supply chains," "high upfront costs," "failures in company cooperation," "lack of consumer enthusiasm and limited dissemination of innovation," and "resource-intensive infrastructure lock-in" (Schulze, 2016). European policy document highlighted factors limiting circular economy progress, including: "economic signals that do not encourage efficient resource use," "lack of awareness and information," "limited sustainable public incentives," "insufficient investment in technology," "pollution mitigation or innovation," and "minor consumer and business acceptance" (European Commission, 2014). Acceleratio identified 22 barriers (Acceleratio; Kirchherr et al., 2018). circular economy challenges have also been explored through case studies of small and medium enterprises, including "environmental culture, financial barriers, limited government support, lack of adequate legislation, information deficits, administrative burdens, and relatively low technical skills" (Wijkma and Skanberg, 2015). circular economy challenges from the perspective of Spanish small and medium enterprises are similar to those discussed above (De Vries and Petersen, 2009; Gladek, 2017). Recent studies categorize circular economy challenges into four main areas: cultural, regulatory, market, and technological, further listing 15 sub-barriers based on literature reviews and semi-structured interviews (Potting et al., 2017).

1.7 Eco-Innovation Framework Integration with Circular Economy as a Promise

Even with supportive political and economic conditions, a key challenge in transitioning to a circular economy lies in cultivating a robust knowledge ecosystem to foster necessary eco-innovations. The current knowledge base, largely focused on traditional linear models,

necessitates generating fresh insights and connecting existing knowledge to the novel demands of circularity. While the European Union has initiated steps, significant gaps remain. Transitioning hinges on stimulating investments and innovations, leading to more eco-efficient production, ultimately demanding radical and systemic eco-innovations to reshape resource-intensive linear patterns. Strategies to reduce resource consumption and enhance circularity rely on both 'hardware' (technologies and infrastructure) and 'software' (skills, expertise, and business models). Moving beyond the traditional "3 R's," the "6 R's" approach offers a more comprehensive framework, requiring significant eco-innovation across industries. Regulatory and consumer pressures also play a crucial role, driving changes in values and prompting firms to adopt more sustainable practices. Supportive policy instruments can foster an innovation culture, addressing environmental, economic, and societal objectives. While instruments for promoting eco-innovations are still nascent, they include regulatory, economic, R&D support, information/networking, and voluntary measures. The transition will be complex, facing obstacles like commodity prices, investment gaps, and limited acceptance of alternative models, requiring comprehensive solutions through favorable framework conditions

Looking at eco-innovation, it mainly transcends mere environmental compliance; it represents a paradigm shift in how we approach economic development. It encompasses the creation and implementation of novel products, processes, systems, and business models that demonstrably minimize environmental harm, reduce pollution, and optimize resource utilization compared to conventional, less sustainable alternatives. This proactive approach not only mitigates negative environmental impacts but also actively fosters sustainability throughout the entire lifecycle of a product or service, from raw material extraction to end-of-life management. Crucially, eco-innovation is not solely an altruistic endeavor; it simultaneously enhances a company's operational efficiency, strengthens its

competitive advantage, and boosts its overall profitability. Several key aspects define the scope and impact of eco-innovation:

- Eco-innovation is not limited to technological advancements. It encompasses a wide spectrum of innovations, including technological breakthroughs, organizational restructuring, social initiatives, and economic strategies. This holistic perspective recognizes that environmental challenges often require multifaceted solutions that address both technical and societal factors.
- The overarching goal of eco-innovation is to decouple economic growth from environmental degradation. This means creating economic value without depleting natural resources, polluting ecosystems, or compromising the well-being of future generations.
- Eco-innovation emphasizes the importance of evaluating the environmental impact of a product or service throughout its entire lifecycle. This includes considering the environmental consequences of raw material extraction, manufacturing processes, transportation, consumer use, and end-of-life disposal or recycling.

The benefits of eco-innovation are far-reaching:

- Eco-innovation can help SMEs access new markets, increase operational efficiency, attract socially responsible investment, and enhance their brand reputation.
- By embracing eco-innovation, businesses can increase their adaptability to environmental pressures, regulatory changes, and resource scarcity.
- Eco-innovation plays a critical role in supporting the transition from linear "take-make-dispose" economic models to circular economies that prioritize resource efficiency, waste reduction, and product longevity.

Eco-innovation is increasingly recognized as a "game-changer" for creating a sustainable and regenerative economy that not only minimizes its environmental footprint but also actively contributes to the restoration and enhancement of natural ecosystems. It represents a pathway towards a future where economic prosperity and environmental stewardship go hand in hand. Based on recent studies, Eco-innovation is widely recognized as a key enabler of circular economy transitions

1.7.1 What is Eco-Innovation Framework?

The Eco-Innovation Framework represents a strategic approach to business and technological development that prioritizes environmental sustainability alongside economic growth. Unlike traditional innovation models that primarily focus on profit maximization, eco-innovation explicitly incorporates environmental considerations into the entire innovation process, from ideation and design to production, marketing, and end-of-life management. There are four types of eco-innovation (see Table 1.3). This framework recognizes that environmental challenges can be a source of innovation, driving the development of new products, services, and business models that are both environmentally beneficial and economically viable.

At its core, the Eco-Innovation Framework seeks to minimize environmental impacts throughout the entire lifecycle of a product or service. This involves reducing resource consumption, minimizing waste generation, preventing pollution, and promoting the use of renewable resources. However, eco-innovation is not simply about "doing less harm." It also aims to create positive environmental outcomes, such as restoring ecosystems, enhancing biodiversity, and improving human health. Several key dimensions characterize the Eco-Innovation Framework. First, it emphasizes a systemic approach,

recognizing that environmental challenges are often interconnected and require integrated solutions. This means considering the entire value chain, from raw material extraction to end-of-life management, and identifying opportunities for improvement at each stage. Second, eco-innovation promotes a proactive and anticipatory approach, encouraging businesses to anticipate future environmental regulations and consumer demands, rather than simply reacting to them. Third, the framework encourages collaboration and knowledge sharing among stakeholders, including businesses, governments, research institutions, and civil society organizations. Finally, eco-innovation emphasizes the importance of measuring and monitoring environmental performance, using metrics such as carbon footprint, water footprint, and material footprint to track progress and identify areas for improvement.

Table 1.3. Four Main Types of Eco-Innovation

Eco-Innovation (type)	Description	Examples
Eco-Product/Service Innovation	This involves developing goods or services that are inherently less environmentally harmful than their conventional counterparts.	Examples include products made from biodegradable materials, energy-efficient electronics, and services that promote resource conservation.
Eco-Process Innovation	This focuses on implementing new production techniques that reduce emissions, minimize waste	Examples include closed-loop manufacturing systems, waste heat recovery technologies, and precision agriculture techniques.

	generation, and optimize resource utilization.	
Eco-Organizational Innovation	This involves making changes to corporate management practices to improve environmental performance	Examples include implementing ISO 14001 environmental management systems, adopting green supply chain management practices, and establishing corporate sustainability goals.
Eco-Marketing Innovation	This focuses on promoting sustainable consumption patterns through innovative marketing strategies	Examples include using sustainable packaging materials, implementing eco-labeling programs, and promoting product stewardship initiatives.

1.7.2 How is an Eco-Innovation Framework Integrated with Circular Economy?

Eco-innovation serves as a primary catalyst and enabler for the transition towards a Circular Economy by fostering the development and implementation of novel products, processes, and services that minimize environmental impacts, drastically reduce waste generation, and lessen our dependence on finite natural resources. It fundamentally shifts industries away from the traditional linear "take-make-dispose" model, characterized by resource depletion and environmental degradation, towards a restorative and regenerative system centered on extending product lifecycles through repairing, reusing, and recycling materials. This transition not only promotes environmental sustainability but also unlocks new avenues for economic growth and value creation with appropriate strategies (see Table 1.4).

Several key connections and benefits highlight the synergistic relationship between Eco-innovation and the Circular Economy:

- Eco-innovation provides the practical tools and strategies necessary to implement the core principles of the Circular Economy, such as the widely recognized "5 R's": Refuse (avoid unnecessary consumption), Reduce (minimize resource use), Reuse (extend product lifecycles), Repurpose (find new uses for existing products), and Recycle (recover valuable materials). By embracing these principles, businesses can significantly reduce their environmental footprint and contribute to a more sustainable future.
- Companies that proactively integrate eco-innovation into their business models and adopt circular practices often experience a range of tangible operational benefits. These include reduced material costs, increased resource efficiency, enhanced supply chain resilience, improved brand reputation, and access to new markets and customers.
- Digitalization plays an increasingly significant role in enabling and accelerating the adoption of circular practices. Advanced technologies such as the Internet of Things (IoT), blockchain, and data analytics can be leveraged to track resources throughout the value chain, optimize product lifecycles, facilitate reverse logistics, and connect producers with consumers in innovative ways.
- Empirical research has demonstrated a strong correlation between eco-innovation and the adoption of circular practices. For example, studies have shown that increasing patent activity in waste management and recycling technologies, particularly in countries like Finland and the Netherlands, directly accelerates the circular use of materials and reduces reliance on virgin resources.

Table 1.4. Strategies on which the eco-innovation is expected to contribute to circular economy

Strategy	Description
Redesigning Materials	This involves creating materials that are inherently less resource-intensive, more durable, and easier to recycle or compost. Examples include using bio-based plastics, developing lightweight materials, and designing products for disassembly and reuse.
Waste Valorization	This focuses on transforming waste materials into valuable feedstock for new manufacturing processes. Examples include converting agricultural waste into biofuels, using industrial byproducts as raw materials, and recovering valuable metals from electronic waste.
Service-Oriented Models	This involves shifting from selling products to providing services that meet customer needs while extending product lifecycles. Examples include leasing equipment, offering product-as-a-service models, and providing repair and maintenance services.
Regional Focus	This emphasizes the importance of promoting localized production loops to reduce transportation costs, minimize carbon emissions, and support local economies. Examples include establishing regional recycling facilities, promoting local sourcing of materials, and supporting community-based repair and reuse initiatives.

1.8 Aim and Objectives of the Thesis

The overarching aim of this DBA thesis is to investigate the potential of integrating an eco-innovation framework with circular economy principles to enhance environmental sustainability within organizations operating in diverse geographical contexts. This research seeks to provide a comprehensive understanding of the challenges and opportunities associated with implementing circular economy strategies and to identify how eco-innovation can be strategically leveraged to overcome these challenges and drive more sustainable outcomes.

To achieve the stated aim, I pursued the following specific objectives:

- To analyze the existing literature on circular economy, eco-innovation, and environmental sustainability to establish a robust theoretical foundation for the research.
- To identify and examine the key barriers and challenges hindering the effective implementation of circular economy principles within organizations across different industries and geographical regions.
- To explore and evaluate the role of an eco-innovation framework in facilitating the adoption and implementation of circular economy strategies, with a particular focus on overcoming identified barriers.
- To compare and contrast the experiences of organizations in the Global South and the Global North in implementing eco-innovation-driven circular economy initiatives, identifying context-specific success factors and challenges.
- To assess the business implications of adopting an integrated eco-innovation and circular economy approach, including impacts on financial performance, competitive advantage, and stakeholder engagement.

- To develop practical recommendations for organizations seeking to transition towards more circular and sustainable business models, informed by the research findings and best practices.

1.9 Specific Research Questions Considered for Investigation

The overarching research question is how can the integration of an eco-innovation framework with circular economy principles enhance environmental sustainability across diverse organizational and geographical contexts?

The list of specific research questions are as follows:

- What are the key barriers and challenges hindering the effective implementation of circular economy principles within organizations?
- How can an eco-innovation framework be effectively integrated with circular economy strategies to overcome these barriers and challenges?
- What are the critical success factors for implementing eco-innovation-driven circular economy initiatives in different regional contexts (e.g., Global South vs. Global North)?
- What specific eco-innovation strategies and circular business models are most effective in driving environmental sustainability across various industries and organizational types?
- What are the key business implications (e.g., financial performance, competitive advantage, stakeholder engagement) of adopting an eco-innovation-driven circular economy approach?

1.10 Structure of the Thesis

This thesis is structured into five distinct chapters, each designed to build upon the previous one to address the central research aim of understanding how the integration of an eco-innovation framework with the circular economy can enhance environmental sustainability.

Chapter I provides a comprehensive introduction to the research context, beginning with an overview of the linear economy and its inherent unsustainability. It then transitions to defining the circular economy, exploring its potential contributions to environmental sustainability, and outlining the global movement towards circularity. The chapter identifies the barriers and challenges hindering circular economy implementation and introduces the eco-innovation framework as a promising solution.

Chapter II details the research design and approach employed in this study. It outlines the theoretical framework underpinning the research, describes the chosen research design, and explains the data collection methods utilized. This chapter provides a clear explanation of the methodology used to gather and analyze the data, ensuring the rigor and validity of the research findings.

Chapter III presents a detailed analysis of case studies from across the globe, categorized by region (Africa, Asia, Europe, Latin America, North America, and Oceania). Each case study examines the implementation of circular economy principles and the role of eco-innovation in driving environmental sustainability. The chapter presents the findings from each case study, highlighting both successes and challenges encountered in different contexts.

Chapter IV synthesizes the findings from the case studies and provides a comprehensive discussion of the research results. It explores the potential of an eco-innovation framework integrated with the circular economy to enhance environmental sustainability, comparing

and contrasting the experiences of the Global South and the Global North. The chapter also presents key lessons learned from the case studies and offers practical recommendations for businesses seeking to implement circular economy principles. Furthermore, it discusses the broader business implications of adopting a circular economy approach.

Chapter V concludes the thesis by summarizing the key findings and contributions of the research. It acknowledges the limitations of the study and identifies opportunities for further exploration. This chapter provides a concise overview of the researchs main conclusions and suggests avenues for future research in this important area.

CHAPTER II

RESEARCH DESIGN AND APPROACH

2.1 Theoretical Framework

This research is grounded in a theoretical framework that integrates concepts from several key areas: the circular economy (CE), eco-innovation (EI), systems thinking, and institutional theory. This integrated framework provides a lens for understanding the complex interplay that influence the adoption and implementation of eco-innovative solutions for promoting circularity (see Figure 2.1).

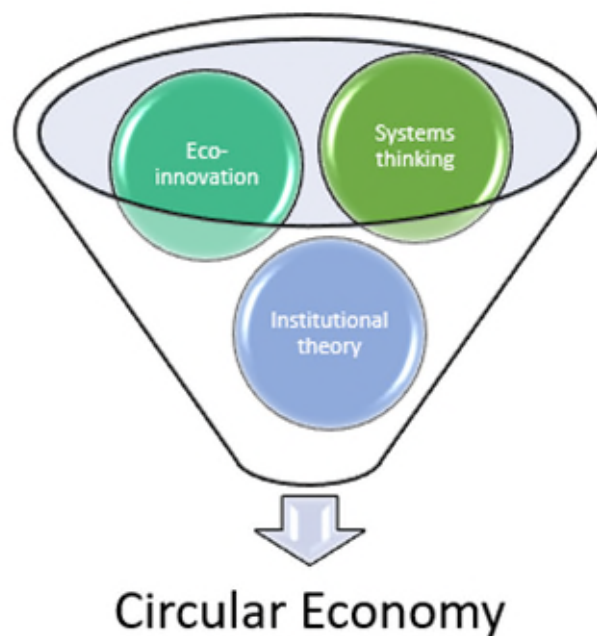


Figure 2.1. A three pillar theoretical framework integrating eco-innovation, systems thinking, and institutional theory to promote circular economy. Source: Author's Own Creation for this DBA thesis

2.1.1 Circular Economy

The CE provides the overarching goal and context for this research. It is defined as an economic system that “aims to minimize waste and maximize resource utilization by keeping products and materials in use for as long as possible. Key principles of the CE include designing for durability, reuse, and recyclability; promoting closed-loop systems”; and shifting from linear “take-make-dispose” models to circular models (Ellen Macarthur Foundation, www.ellenmacarthurfoundation.org).

2.1.2. Eco-Innovation

EI is defined as innovation that results in reduced environmental impact, whether through product, process, organizational, or marketing innovations. “EI can be incremental or radical, and it can be driven by a variety of factors, including regulatory pressures, market opportunities, and social values” (Fröhlich et al., 2024). Here I focus on understanding the types of EI that are most effective in addressing the challenges of CE implementation.

2.1.3 Systems Thinking

Systems thinking provides a framework for understanding the interconnectedness and complexity of CE systems. It emphasizes the “importance of considering the entire lifecycle of products and materials, as well as the interactions between different actors and stakeholders” (Lindgreen et al., 2018). Here, I adopt a systems perspective to identify the key leverage points for promoting EI and accelerating the transition to a CE.

2.1.4 Institutional Theory

Institutional theory examines the role of institutions (e.g., regulations, norms, and values) in shaping organizational behavior and innovation. It highlights the importance of

understanding the institutional context in which EI is developed and implemented. This research considers how institutional factors, such as government policies, industry standards, and consumer preferences, influence the adoption of EI for CE.

2.2 Research Design

Based on the understandings from the theoretical framework core areas, a secondary data based research was designed to realise the research questions and aim.

2.2.1 Data Collection

Two types of data collection was done here; *One is the scholarly articles*, where the data for this thesis was gathered from reputable, peer-reviewed academic journals and grey literature. A specific collection of literature was compiled using two prominent databases for academic research: the Web of Science (WoS) Core Collection and Scopus. Relevant materials were located through keyword searches, employing Boolean operators, within the titles, abstracts, and author-provided keywords of articles and reviews published in English. This approach was chosen under the assumption that it would capture the most recent and globally relevant research. The primary objective was to ensure the inclusion of pertinent, peer-reviewed publications. Recognizing that the relationship between eco-innovation and the circular economy is still evolving and not fully established, it was understood from the beginning that relying solely on the target terms could introduce exclusion and bias. To mitigate potential biases in keyword selection, an initial exploratory search was conducted using only the terms "innovat" AND ("circular economy" OR "circular-economy"). This preliminary search yielded downloadable articles across both databases (duplicates were removed). While the results were limited, these articles provided a valuable set of unique keywords (as provided by the article authors). Given that

keywords offer concise and critical information about the content of each article, they were used as a guide to identify additional relevant publications. Analysis of keywords appearing at least twice revealed the descriptors "industrial symbiosis," "industrial ecology," "urban symbiosis," and "eco-industrial park." Here, based on the obtained results, I compiled the sources to find out the barriers and challenges for circular economy implementation as well as the eco-innovation integration based on the theoretical framework. The list of identified barriers and challenges from the literature were given in Appendix A.

For case study search and to gain a comprehensive understanding of circular economy implementation across diverse national contexts, a case study approach was adopted. Data collection focused on identifying and analyzing relevant initiatives, policies, and business practices in selected countries. The selection of countries aimed to represent a range of geographical regions, economic development levels, and policy approaches to the CE. A multi-faceted data collection strategy was employed, combining desk research with targeted searches of online databases and grey literature. Keyword searches were conducted in local languages, where feasible, to capture a broader range of relevant information. The following keywords, and their translations where appropriate, were used in combination with country names: "Circular Economy" OR "Circular-Economy" OR "Resource Efficiency" "Waste Management" "Sustainable Consumption" "Extended Producer Responsibility" "Eco-Innovation" "Industrial Symbiosis" "Remanufacturing" "Recycling" "Upcycling" "Closed-Loop System". Based on search results, the collected data was validated with a case study collection data base named Ellen Macarthur Foundation (www.ellenmacarthurfoundation.org). The list of identified case studies from the literature were given in Appendix B.

2.2.2 Methodology

This research employed a multiple case study methodology to investigate the challenges hindering circular economy (CE) implementation and to explore the potential for eco-innovation (EI) to address these challenges. Case studies were selected to represent a diverse range of geographical regions, economic development levels, and industry sectors, ensuring a comprehensive understanding of the complexities involved. Data collection involved a combination of desk research and expert consultation. Desk research included a review of policy documents, industry reports, academic publications, and news articles related to CE and EI in each case study. The analysis of the case study data followed a two-stage approach:

Approach 1 - Within-Case Analysis

For each case study, a thematic analysis was conducted to identify the key challenges hindering CE implementation. This involved a systematic coding of the data, using both deductive (based on pre-defined categories such as policy, technology, market) and inductive (emerging from the data) programs. The identified challenges were then categorized and prioritized based on their frequency and impact.

Approach 2 - Cross-Case Analysis

A comparative analysis was conducted to identify common challenges and unique context-specific factors across the case studies. This involved creating a matrix that summarized the key challenges, potential EI applications, and potential benefits for each case study. This facilitated the identification of patterns and the development of overarching themes related to the role of EI in addressing CE challenges.

CHAPTER III

ANALYSIS AND FINDINGS

This chapter presents the research finding for research questions RQ-1: What are the key barriers and challenges hindering the effective implementation of circular economy principles within organizations?, RQ-2: How can an eco-innovation framework be effectively integrated with circular economy strategies to overcome these barriers and challenges? Followed by analysis on the circular economy case studies in different geographical contexts mainly to understand the how eco-innovation can be leveraged, which allowed me to explore the results for RQ-3: What are the critical factors or strgetiges for implementing eco-innovation-driven circular economy initiatives in different regional contexts (e.g., Global South vs. Global North)?.

3.1 Ways to Integrate the Eco-Innovation with Circular Economy

This section presents the results of my analysis, which highlights the transformative role of eco-innovation in the transition to a circular economy. My findings from the literature reveal two primary modes of integration: eco-innovations as critical determinants for establishing closed-loop economic systems, and eco-innovation as a catalyst for the fundamental transformation of business models.

3.1.1 First Mode of Integration for Establishing Closed-Loop Economic Systems

First, eco-innovative practices emerge as critical enablers for establishing closed-loop economic systems. This mode of integration emphasizes the role of eco-innovations in optimizing resource utilization, minimizing waste generation, and facilitating the recovery and reuse of materials. Examples include the development of recyclable materials, the

implementation of closed-loop manufacturing processes, and the design of products for disassembly and remanufacturing. This mechanism focuses on the practical application of eco-innovative technologies and processes to optimize resource flows, minimize waste generation, and facilitate the recovery and reuse of materials. The literature highlights examples such as the development of biodegradable packaging, the implementation of industrial symbiosis networks, and the design of products for extended lifespans.

3.1.2 Second Mode of Integration for the transformation of business models.

Second, eco-innovation acts as a catalyst for the fundamental transformation of business models. This mode of integration focuses on how eco-innovations can drive the creation of new value propositions, revenue streams, and competitive advantages by aligning business practices with circular economy principles. Examples include the adoption of product-as-a-service models, the development of sharing economy platforms, and the implementation of circular supply chain strategies. This mechanism emphasizes the strategic role of eco-innovations in driving the creation of new value propositions, revenue streams, and competitive advantages by aligning business practices with circular economy principles. Examples include the adoption of leasing models, the development of reverse logistics systems, and the implementation of circular procurement strategies. These two mechanisms, while distinct, are interconnected and mutually reinforcing, underscoring the holistic nature of eco-innovation in driving the transition to a circular economy.

3.2 Results on Eco-Innovation Addressing Challenges and Opportunities in Circular Economy Implementation

In this section, I categorised my findings on how eco-innovation addresses the circular economy implementation challenges into 5 categories; namely technical barriers, financial

barrier, infrastructure barriers, institutional barriers, and societal barriers. Each of these are presented in below sections.

3.2.1 Addressing the Technical Barrier with Eco-innovation

The technological barriers identified reveal a substantial opportunity for integrating eco-innovation to advance circular economy principles. The current lack of end-of-life considerations in product design, coupled with limited recycled material availability and concerns regarding the quality of recycled materials, necessitates innovative design approaches and material sourcing strategies. Furthermore, the absence of proven circular economy projects, technical frameworks for product redesign, and efficient tools for assessing project effectiveness highlights the need for developing and implementing novel technologies and methodologies. Addressing these challenges through eco-innovation, such as designing for disassembly, utilizing advanced recycling techniques, and developing robust data models for circularity assessment, can unlock significant environmental and economic benefits, paving the way for a more sustainable and resource-efficient future.

3.2.2 Addressing the Financial Barrier with Eco-innovation

The financial barriers present significant obstacles to circular economy adoption, including high upfront investment costs, the economic disincentive of low virgin material prices, limited funding for circular business models, and challenges in ensuring predictable return flows. Furthermore, the difficulty in accounting for environmental costs, the dominance of short-term shareholder agendas, increased management costs, and capital tied up between stakeholders all contribute to the economic challenges. Eco-innovation can play a crucial role in mitigating these barriers by driving down costs through resource efficiency, developing new revenue streams from waste valorization, attracting investment through

demonstrated sustainability performance, and creating more resilient and predictable supply chains. By fostering innovative business models and financial instruments, eco-innovation can unlock the economic potential of the circular economy and make it a more attractive and viable option for businesses.

3.2.3 Addressing the Infrastructural Barrier with Eco-innovation

The infrastructural barriers present significant impediments to the widespread adoption of circular economy practices. These include limited application of new business models, a lack of secure information exchange systems, capacity limitations in reverse logistics, inadequate information management systems, a shortage of qualified environmental management professionals, limited dissemination of innovation, resource-intensive infrastructure lock-in, a scarcity of large-scale demonstration projects, and a lack of technical resources and facilities. Eco-innovation can play a transformative role in overcoming these barriers by fostering the development of new, more efficient business models, enabling the creation of secure and transparent information exchange platforms, optimizing reverse logistics systems through technological advancements, and promoting the development of innovative training programs to address the skills gap. Furthermore, eco-innovation can drive the creation of resource-efficient infrastructure, facilitate the scaling up of successful demonstration projects, and promote the sharing of technical resources and facilities, ultimately creating a more supportive and enabling environment for circular economy initiatives.

3.2.4 Addressing the Institutional Barrier with Eco-innovation

The institutional barriers present significant hurdles to the widespread adoption of circular economy principles. These include a lack of global consensus, obstructing laws and

regulations, a lack of supportive policy frameworks and smart regulations, limited circular procurement practices, ineffective integration of circularity principles into policy innovation, persistent financial incentives favoring linear business models, inefficient recycling policies, governance concerns related to duties, obligations, and ownership, a lack of support from public institutions, and a lack of confidence and trust hampering information exchange. Eco-innovation can be fostered by addressing these institutional barriers through the development of harmonized global standards, the removal of regulatory obstacles, the implementation of supportive policy frameworks and smart regulations, the promotion of circular procurement practices, the effective integration of circularity principles into policy innovation, the realignment of financial incentives to favor circular business models, the implementation of efficient recycling policies, the clarification of governance structures, the strengthening of support from public institutions, and the building of confidence and trust to facilitate information exchange. By creating a more supportive and enabling institutional environment, we can unlock the full potential of eco-innovation to drive the transition to a circular economy.

3.2.5 Addressing the Societal Barrier with Eco-innovation

The societal barriers present significant challenges to the widespread adoption of circular economy principles. These include a hesitant organizational culture, a lack of awareness of benefits and readiness to collaborate across the value chain, a secure attachment to linear systems, a lack of visionary leadership, differing employee attitudes and behaviors, changing consumer preferences, a lack of consumer awareness, consumer preference for new products, dynamic consumer mindsets, customer type restrictions, challenges in external partner cooperation, a lack of willingness to contribute to sustainability, and a lack of confidence and trust hindering information exchange. Eco-innovation can be embraced

and driven by addressing these societal barriers through fostering a culture of innovation and collaboration within organizations, raising awareness of the benefits of circularity and promoting value chain collaboration, challenging the attachment to linear systems through education and engagement, cultivating visionary leadership, aligning employee attitudes and behaviors through training and incentives, understanding and responding to changing consumer preferences, raising consumer awareness through targeted campaigns, promoting the value of remanufactured and reused products, adapting to dynamic consumer mindsets through flexible business models, overcoming customer type restrictions through inclusive design, fostering external partner cooperation through trust-building initiatives, cultivating a willingness to contribute to sustainability through shared value creation, and building confidence and trust to facilitate information exchange. By creating a more engaged and supportive society, we can unlock the full potential of eco-innovation to drive the transition to a circular economy.

3.3 Case Studies in Africa and Their Results

In Africa, six case studies, one from Ghana, two from Kenya, one from Uganda, one from South Africa, and one more as a consolidated one covering Sub-Saharan Africa and the Caribbean are considered. Analysis of each case study in the context of without eco-innovation and with eco-innovation integration is given below.

Case Study – 1: Serendipalm/Dr. Bronner’s (Ghana)

“A regenerative supply chain alternative for palm oil”

Serendipalm/Dr. Bronner's in Ghana provides a compelling example of a regenerative supply chain alternative for palm oil, demonstrating the potential for integrating circular economy principles with ethical and sustainable sourcing. This case highlights several key aspects relevant to the research objectives. First, Serendipalm/Dr. Bronner's addresses the challenge of destructive environmental practices and the exploitation of local communities often associated with global palm oil supply chains. By building a vertically-integrated, regenerative supply chain, the company showcases how circular economy principles can be applied to overcome these challenges and create positive social and environmental outcomes. The company's approach incorporates several eco-innovation strategies. By working with smallholder farmers, promoting regenerative cultivation methods, and processing the oil in a local mill, Serendipalm/Dr. Bronner's minimizes environmental impact and maximizes social benefits. The adoption of mixed agroforestry methods, which integrate palm and cocoa production with the cultivation of secondary crops, further enhances the circularity of the system by increasing biodiversity, improving soil health, and providing additional revenue streams for farmers. This aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Serendipalm/Dr. Bronner's case. Dr. Bronner's commitment to ethical and sustainable sourcing, its willingness to invest in building a regenerative supply chain, and its collaboration with local communities have been essential to its success. The case also highlights the importance of transparency and traceability in ensuring the integrity of the supply chain. The business implications of Serendipalm/Dr. Bronner's approach are also noteworthy. The company has demonstrated the potential for economic benefits through increased demand for ethically sourced palm oil and the creation of a more resilient and sustainable supply chain. This suggests that adopting an

eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Serendipalm, a project initiated by Dr. Bronner's in Ghana, is an example of a sustainable palm oil supply chain focused on regenerative agriculture and community development. The project works with smallholder farmers, providing training in regenerative cultivation methods and supporting the cultivation of organic palm fruit trees. The oil is processed in a local mill, employing local people at well above average living wages. The overall goal is to create a more ethical and environmentally responsible palm oil supply chain. The implementation of these practices has led to several positive outcomes. Serendipalm has avoided deforestation, restored degraded land, improved soil health, increased biodiversity, and provided economic benefits to local communities. These results demonstrate the potential for sustainable sourcing practices to enhance environmental sustainability and social equity.

Potential Challenges and Barriers: Despite the positive results, Serendipalm faces several challenges and barriers. These include the need for ongoing training and support for farmers, the potential for pests and diseases to impact crop yields, and the challenges of managing a complex supply chain. Additionally, changing market conditions and consumer preferences could impact the economic viability of the project.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing regenerative agriculture practices, Serendipalm has the potential to further enhance its environmental sustainability through the integration of eco-

innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire supply chain, from farm to consumer.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Serendipalm. These include:

- Implementing precision agriculture technologies, such as remote sensing and drone monitoring, to optimize resource use and minimize environmental impact.
- Transitioning to renewable energy sources, such as solar and biogas, to power the local mill and reduce reliance on fossil fuels.
- Implementing waste valorization strategies to convert agricultural waste (e.g., palm kernel shells, empty fruit bunches) into valuable products, such as biochar or compost.
- Utilizing blockchain technology to enhance transparency and traceability throughout the supply chain, ensuring the integrity of the palm oil and verifying its regenerative credentials.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Serendipalm can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the project's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Precision agriculture technologies and renewable energy systems can improve resource efficiency, reducing costs and minimizing environmental impact.

- Eco-innovation can enhance the provision of ecosystem services, such as carbon sequestration, water filtration, and biodiversity support, further contributing to environmental sustainability.
- By creating new products and markets, and by reducing costs through resource efficiency, eco-innovation can improve the livelihoods of local communities and enhance the resilience of the supply chain.

Case Study – 2: Insectipro/Sanergy (Kenya)

“Insects as part of a circular economy for food”

Insectipro and Sanergy in Kenya provide a compelling example of insects as part of a circular economy for food, demonstrating the potential for integrating circular economy principles with sustainable waste management and food security. This case highlights several key aspects relevant to the research objectives. First, Insectipro and Sanergy address the challenge of organic waste management in rapidly growing African cities, where it is a costly issue both in financial terms and as a public health concern. By harnessing the metabolic power of insects to transform organic waste into revenue-earning products, the companies showcase how circular economy principles can be applied to overcome environmental challenges and create positive social and economic outcomes. The companies' approaches incorporate several eco-innovation strategies. Insectipro feeds agricultural by-products and organic waste to crickets to produce nutrient-rich flour used to fortify children's porridge, while Sanergy collects human waste with organic waste and feeds it to black soldier fly larvae to create nutritious insect feed for fish and livestock. Both companies produce soil-enhancing compost as a by-product, which is sold to farmers

close to the city to support healthy growing practices. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Insectipro and Sanergy case. The companies' innovative use of insects to transform waste into valuable products, their focus on addressing multiple urban challenges in a holistic way, and their commitment to supporting local communities have been essential to their success. The case also highlights the importance of adapting technologies and business models to specific local contexts. The business implications of Insectipro and Sanergy's approach are also noteworthy. The companies have demonstrated the potential for economic benefits through the sale of insect-based products and compost, as well as through the reduction of waste management costs. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Insectipro and Sanergy, both based in Kenya, are examples of companies focused on using insects to address waste management and food security challenges. Insectipro uses crickets to transform agricultural by-products and organic waste into nutrient-rich flour for children's porridge. Sanergy uses black soldier fly larvae to convert human waste and organic waste into insect feed for fish and livestock. Both companies produce compost as a by-product. The overall goal is to create a more sustainable and circular food system. The implementation of these practices has led to several positive outcomes. Insectipro and Sanergy have reduced waste, produced valuable insect-based products and compost, and contributed to improved nutrition and food security. These results demonstrate the potential for innovative approaches to address complex urban challenges.

Potential Challenges and Barriers: Despite the positive results, Insectipro and Sanergy face several challenges and barriers. These include the need for ongoing research and development to optimize insect farming practices, the potential for regulatory hurdles related to the use of insects in food and feed, and the need for consumer education and acceptance of insect-based products. Additionally, the scalability of these approaches may be limited by the availability of organic waste and the capacity of local markets.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon their existing insect-based waste management and food production systems, Insectipro and Sanergy have the potential to further enhance their environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from waste collection to product distribution.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Insectipro and Sanergy. These include:

- Implementing optimized waste collection systems to improve the efficiency and effectiveness of waste sourcing.
- Transitioning to renewable energy sources, such as solar and biogas, to power insect farming operations and reduce reliance on fossil fuels.
- Implementing water management technologies to minimize water consumption and reduce wastewater generation.
- Exploring opportunities to use circular packaging solutions for insect-based products, minimizing waste and promoting recyclability or compostability.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Insectipro and Sanergy can further enhance their environmental sustainability in several ways:

- Eco-innovation can help to reduce the companies' overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Optimized waste collection systems and water management technologies can improve resource efficiency, reducing costs and minimizing environmental impact.
- By producing valuable compost, Insectipro and Sanergy can contribute to improved soil health and reduced reliance on synthetic fertilizers.
- By producing nutrient-rich insect-based products, Insectipro and Sanergy can contribute to improved food security and reduced malnutrition.

Case Study – 3: Safi Organics (Kenya)

“Farm by-products increase yields and sequesters carbon”

Safi Organics in Kenya provides a compelling example of how farm by-products can increase yields and sequester carbon, demonstrating the potential for integrating circular economy principles with sustainable agriculture and climate change mitigation. This case highlights several key aspects relevant to the research objectives. First, Safi Organics addresses the challenge of rice husk waste, which is often burned in many regions, leading to significant disruption and health issues due to the high particulate content of the smoke. By collecting discarded rice husks and transforming them into a nutrient and carbon-rich organic biochar fertilizer called Safi Sarvi, Safi Organics showcases how circular economy

principles can be applied to overcome environmental challenges and create positive social and economic outcomes. The company's approach incorporates several eco-innovation strategies. By valorizing a resource that otherwise becomes waste, Safi Organics reduces pollution, improves soil health, and increases farmer profits. The local, distributed manufacturing model creates local jobs and avoids the volatility of international fertilizer prices. The organic biochar reduces soil acidity, improves soil structure, and sequesters about 1.7 tonnes of CO₂e per acre. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Safi Organics case. The company's innovative use of rice husk waste to produce biochar fertilizer, its focus on addressing multiple challenges in a holistic way, and its commitment to supporting local communities have been essential to its success. The case also highlights the importance of adapting technologies and business models to specific local contexts. The business implications of Safi Organics' approach are also noteworthy. The company has demonstrated the potential for economic benefits through increased farmer profits, reduced input costs, and the creation of local jobs. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Safi Organics, based in Kenya, is an example of a company focused on transforming rice husk waste into organic biochar fertilizer. The company collects discarded rice husks from rice-growing areas and processes them into Safi Sarvi, a nutrient and carbon-rich fertilizer. The overall goal is to reduce waste, improve soil health, and increase farmer profits. The implementation of these practices has led to several positive outcomes. Safi Organics has

reduced rice husk burning, improved soil health, increased crop yields, and created local jobs.

Potential Challenges and Barriers: Despite the positive results, Safi Organics faces several challenges and barriers. These include the need for ongoing research and development to optimize biochar production and application, the potential for fluctuations in rice husk availability, and the need for farmer education and adoption of biochar fertilizer. Additionally, the scalability of this approach may be limited by the availability of rice husk waste and the capacity of local markets.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing biochar production system, Safi Organics has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from rice husk collection to fertilizer distribution.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Safi Organics. These include:

- Implementing optimized rice husk collection systems to improve the efficiency and effectiveness of waste sourcing.
- Transitioning to renewable energy sources, such as solar and biogas, to power biochar production operations and reduce reliance on fossil fuels.
- Implementing precision agriculture technologies to optimize fertilizer application and minimize nutrient runoff.

- Implementing advanced monitoring techniques to accurately measure and verify carbon sequestration rates in the soil, allowing farmers to participate in carbon markets.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Safi Organics can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Optimized rice husk collection systems and renewable energy systems can improve resource efficiency, reducing costs and minimizing environmental impact.
- By producing valuable biochar fertilizer, Safi Organics can contribute to improved soil health and reduced reliance on synthetic fertilizers.
- By sequestering carbon in the soil, Safi Organics can contribute to climate change mitigation and help farmers adapt to changing climate conditions.

Case Study – 4: One-acre farm (Uganda)

“How to run a profitable circular farm: one-acre farm”

One-Acre Farm in Uganda provides a compelling example of how to run a profitable circular farm, demonstrating the potential for integrating circular economy principles with sustainable agriculture and food security. This case highlights several key aspects relevant to the research objectives. First, One-Acre Farm addresses the challenge of shrinking farm sizes in the region, due to a rising population and fragmentation of farms. By emulating

nature's cyclical and regenerative processes, the farm generates multiple revenue streams and significantly reduces running costs and waste, showcasing how circular economy principles can be applied to overcome these challenges and create positive social and economic outcomes. The farm's approach incorporates several eco-innovation strategies. By integrating livestock and plant crops into a symbiotic relationship, the farm creates interconnected resource flows. For example, maggots are grown on pig waste to feed to chickens and fish, and the waste is further broken down by worms, then combined with cattle and pig urine to provide fertilizer for perennial crops. The farm also embraces technology, such as hydroponics and aquaponics, to boost efficiency and attract young people to farming. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the One-Acre Farm case. Dr. Naluyima's innovative farm design, her focus on creating a mixed-farming system that integrates livestock and plant crops, and her use of technology to boost efficiency have been essential to her success. The case also highlights the importance of adapting farming practices to specific local contexts. The business implications of One-Acre Farm's approach are also noteworthy. The farm generates significant revenue, reduces input costs, and protects local biodiversity. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

One-Acre Farm in Uganda is an example of a highly profitable, mixed-farm that integrates livestock and plant crops into a symbiotic relationship. The farm is divided into zones with interconnected resource flows, where waste from one part of the farm becomes a resource for another. The overall goal is to maximize productivity and profitability while

minimizing waste and environmental impact. The implementation of these practices has led to several positive outcomes. One-Acre Farm has increased revenue, reduced input costs, protected local biodiversity, and contributed to food security. These results demonstrate the potential for innovative farming practices to address agricultural and environmental challenges.

Potential Challenges and Barriers: Despite the positive results, One-Acre Farm faces several challenges and barriers. These include the need for ongoing management and maintenance of the farm's complex systems, the potential for pests and diseases to impact crop and livestock production, and the need for access to markets and financing. Additionally, the scalability of this approach may be limited by the availability of land and resources.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular farming practices, One-Acre Farm has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire farm system, from resource inputs to product outputs.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at One-Acre Farm. These include:

- Implementing optimized resource management practices to minimize water consumption, reduce energy use, and improve nutrient cycling.

- Transitioning to renewable energy sources, such as solar and biogas, to power farm operations and reduce reliance on fossil fuels.
- Implementing biodiversity enhancement strategies to promote the conservation of native species and improve ecosystem services.
- Utilizing data analytics and sensor technologies to monitor farm performance, optimize resource allocation, and improve decision-making.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, One-Acre Farm can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the farm's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Optimized resource management practices and renewable energy systems can improve resource efficiency, reducing costs and minimizing environmental impact.
- By implementing biodiversity enhancement strategies, One-Acre Farm can contribute to improved ecosystem services, such as pollination, pest control, and water filtration.
- By sequestering carbon in the soil and reducing greenhouse gas emissions, One-Acre Farm can contribute to climate change mitigation and help farmers adapt to changing climate conditions.

Case Study – 5: Matchmaking Companies to Turn Waste into Profit: Cape Town

“Matchmaking companies to turn waste into profit: Cape Town”

The Western Cape Industrial Symbiosis Programme (WISP) in Cape Town provides a compelling example of how to facilitate industrial symbiosis and turn waste into profit, demonstrating the potential for integrating circular economy principles with economic development and environmental sustainability. This case highlights several key aspects relevant to the research objectives. First, WISP addresses the challenge of waste management and resource efficiency by connecting companies and helping them identify opportunities to exchange unused or residual resources. By diverting waste from landfill and creating new revenue streams, WISP showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The program's approach incorporates several eco-innovation strategies. By providing technical expertise, facilitating business workshops, and conducting site visits, WISP helps companies identify opportunities to reuse and recycle secondary raw materials. The program also quantifies the benefits of exchanging waste materials, providing much-needed evidence on the circular economy opportunity for businesses. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the WISP case. The program's collaborative approach, its focus on mutual benefits for participating companies, and its ability to adapt to changing circumstances have been essential to its success. The case also highlights the importance of government support and funding in enabling the transition to a circular economy. The business implications of WISP's approach are also noteworthy. The program has generated significant economic benefits, created jobs, and reduced greenhouse gas emissions. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

The Western Cape Industrial Symbiosis Programme (WISP) in Cape Town is an example of a program focused on connecting companies to exchange unused or residual resources. WISP facilitators conduct site visits to understand production processes and identify opportunities for reuse and recycling. The overall goal is to divert waste from landfill, create jobs, and generate economic benefits. The implementation of these practices has led to several positive outcomes. WISP has diverted significant amounts of waste from landfill, saved CO₂e emissions, created jobs, and generated additional revenue and cost savings for participating companies. These results demonstrate the potential for industrial symbiosis to address waste management and economic development challenges.

Potential Challenges and Barriers: Despite the positive results, WISP faces several challenges and barriers. These include the need for ongoing funding and support, the potential for fluctuations in waste material availability, and the need for company buy-in and participation. Additionally, regulatory hurdles and market barriers could hinder the adoption of industrial symbiosis practices.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing industrial symbiosis practices, WISP has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on developing and implementing innovative solutions that address specific environmental challenges and promote sustainable economic development.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at WISP. These include:

- Promoting the use of recycled and secondary raw materials in manufacturing processes, and designing products that are durable, repairable, and recyclable.
- Investing in technologies that can convert waste materials into valuable products, such as biochar, compost, and energy.
- Encouraging businesses to adopt circular business models, such as product-as-a-service, leasing, and sharing, that reduce resource consumption and extend product lifecycles.
- Implementing data analytics and artificial intelligence (AI) to optimize resource flows, identify new synergies, and improve the efficiency of the industrial symbiosis network.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, WISP can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the overall environmental footprint of economic activities by minimizing resource consumption, waste generation, and pollution.
- By promoting the use of recycled materials, implementing waste valorization technologies, and adopting circular business models, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.

- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 6: Agricycle (Sub-Saharan Africa and the Caribbean)

“Reducing food losses, increasing profits: Agricycle”

Agricycle provides a compelling example of how to reduce food losses and increase profits for smallholder farmers, demonstrating the potential for integrating circular economy principles with sustainable agriculture and economic development. This case highlights several key aspects relevant to the research objectives. First, Agricycle addresses the challenge of food waste in countries like Kenya and Uganda, where a significant portion of the food that is grown never makes it to the market due to poor infrastructure and a lack of cold storage. By manufacturing and distributing solar dehydrator technologies that enable food to be preserved for longer, Agricycle showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The company's approach incorporates several eco-innovation strategies. By upcycling food that would otherwise be wasted, Agricycle reduces pressure on food production and its associated negative impacts on biodiversity. The company also empowers local communities by purchasing the resulting products directly from cooperatives and providing on-the-job skills training. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Agricycle case. The company's innovative use of solar dehydrator technology, its focus on empowering

local communities, and its ability to create brands to sell these products in global markets have been essential to its success. The case also highlights the importance of addressing the root causes of food waste and providing farmers with the tools and skills they need to succeed. The business implications of Agricycle's approach are also noteworthy. The company has been able to increase farmer incomes, reduce food waste, and create new market opportunities. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Agricycle works with smallholder farmers around the world to upcycle food that would otherwise be wasted. The company manufactures and distributes solar dehydrator technologies that enable food to be preserved for longer, purchases the resulting products directly from cooperatives, and creates brands to sell these products in global markets. The overall goal is to reduce food losses, increase farmer incomes, and promote sustainable agriculture. The implementation of these practices has led to several positive outcomes. Agricycle has diverted significant amounts of food from being wasted, increased farmer incomes, and provided on-the-job skills training to local communities. These results demonstrate the potential for innovative technologies and business models to address food waste and poverty.

Potential Challenges and Barriers: Despite the positive results, Agricycle faces several challenges and barriers. These include the need for ongoing maintenance and repair of the solar dehydrator technologies, the potential for fluctuations in crop yields and market demand, and the need for access to financing and investment. Additionally, regulatory

hurdles and trade barriers could hinder the company's ability to sell its products in global markets.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing food upcycling practices, Agricycle has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the production of the solar dehydrator technologies to the distribution and marketing of the upcycled food products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Agricycle. These include:

- Implementing sustainable manufacturing practices in the production of the solar dehydrator technologies, such as using recycled materials, reducing energy consumption, and minimizing waste generation.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Using sustainable packaging materials for the upcycled food products, such as compostable or biodegradable packaging, to minimize waste and reduce environmental impact.
- Implementing strategies to reduce the carbon footprint of the company's operations, such as optimizing transportation routes, promoting local sourcing, and investing in carbon offset projects.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Agricycle can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By using recycled materials, reducing energy consumption, and optimizing transportation routes, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and investing in carbon offset projects, eco-innovation can contribute to climate change mitigation and help farmers adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

3.4 Case Studies in Asia and Their Results

In Asia, thirteen case studies, two from India, nine from China, one from Japan and one from Indonesia are considered. Analysis of each case study in the context of without eco-innovation and with eco-innovation integration is given below.

Case Study – 7: Andhra Pradesh Community-managed Natural Farming (India)

“Andhra Pradesh Community-managed Natural Farming programme”

The Andhra Pradesh Community-managed Natural Farming (APCNF) programme provides a compelling example of how to transition to a circular economy in agriculture at scale, demonstrating the potential for integrating circular economy principles with sustainable agriculture, economic development, and environmental sustainability. This case highlights several key aspects relevant to the research objectives. First, APCNF addresses the challenges of farmer indebtedness, soil degradation, and biodiversity loss by promoting a system of agroecological principles known as Natural Farming. By replacing harmful pesticides with biological alternatives, covering the ground with crops all year round, and integrating livestock, APCNF showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The program's approach incorporates several eco-innovation strategies. By training farmers in Natural Farming methods, APCNF empowers them to reduce costs, improve health, and create better livelihoods. The program also leverages community networks, such as women's self-help groups, to disseminate training and knowledge on Natural Farming. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the APCNF case. The program's government leadership, its focus on building the capacity of farmers, and its use of community networks have been essential to its success. The case also highlights the importance of adapting farming practices to specific local contexts and working with academia to build scientific evidence on the impacts of Natural Farming. The business implications of APCNF's approach are also noteworthy. The program has been able to increase farmer incomes, improve biodiversity and climate resilience, and reduce exposure to harmful chemicals. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

The Andhra Pradesh Community-managed Natural Farming (APCNF) programme is a government-led training programme in Natural Farming approaches that aims to reach all 6 million farmers in the state by 2031. The programme promotes the use of biological materials in place of chemical pesticides and fertilisers and seeks to embed Natural Farming approaches in farming communities in the long term. The overall goal is to address farmer debt, soil degradation, and biodiversity loss. The implementation of these practices has led to several positive outcomes. APCNF has increased farmer incomes, improved biodiversity and climate resilience, and reduced exposure to harmful chemicals. These results demonstrate the potential for sustainable agriculture practices to address agricultural and environmental challenges.

Potential Challenges and Barriers: Despite the positive results, APCNF faces several challenges and barriers. These include the need for ongoing funding and support, the potential for resistance from farmers who are accustomed to conventional farming practices, and the need for access to markets and infrastructure. Additionally, regulatory hurdles and trade barriers could hinder the adoption of Natural Farming practices.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing Natural Farming practices, APCNF has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on developing and implementing innovative solutions that address specific environmental challenges and promote sustainable economic development.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at APCNF. These include:

- Implementing precision agriculture technologies to optimize resource use, reduce waste, and improve crop yields.
- Transitioning to renewable energy sources, such as solar and biogas, to power farm operations and reduce reliance on fossil fuels.
- Developing innovative ways to valorize agricultural waste, such as converting it into compost, biochar, or biogas.
- Utilizing data analytics and artificial intelligence (AI) to monitor farm performance, optimize resource allocation, and improve decision-making.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, APCNF can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the overall environmental footprint of agricultural activities by minimizing resource consumption, waste generation, and pollution.
- By implementing precision agriculture technologies, transitioning to renewable energy sources, and valorizing agricultural waste, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and sequestering carbon in the soil, eco-innovation can contribute to climate change mitigation and help farmers adapt to changing climate conditions.

- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 8: CATL-Brunp (China)

“Redesigning the battery value chain: CATL-Brunp”

CATL-Brunp provides a compelling example of how to redesign the battery value chain, demonstrating the potential for integrating circular economy principles with sustainable manufacturing, resource management, and supply chain resilience. This case highlights several key aspects relevant to the research objectives. First, CATL-Brunp addresses the challenge of increasing the supply of critical minerals for electric vehicles (EVs) and renewable energy storage by pioneering a circular approach to battery and battery material management. By designing batteries with long life and easy disassembly, monitoring and optimising performance throughout use, promoting battery swapping, implementing cascade utilisation, and recycling to recover valuable materials, CATL-Brunp showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The CATL-Brunp's approach incorporates several eco-innovation strategies. By extending battery lifespan through reuse applications and circular business models, CATL-Brunp reduces the demand for virgin minerals. The company also scales up the quantity and quality of material recovery and recycling, reducing waste and promoting resource efficiency. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the CATL-Brunp case. The

company's leadership in battery manufacturing, its investment in recycling processing capacity, and its commitment to circularity have been essential to its success. The case also highlights the importance of collaboration among industry partners, government agencies, and research institutions. The business implications of CATL-Brunp's approach are also noteworthy. The company has been able to reduce exposure to supply disruptions, mitigate the risks of material price volatility, and create new forms of value. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

CATL, the world's largest battery manufacturer, alongside its subsidiary Brunp Recycling (Brunp), is pioneering a circular approach to battery and battery material management. CATL is committed to increasing the proportion of recycled materials in its batteries. Brunp produces cathode precursor materials using multiple feedstock sources, including a growing proportion of critical minerals recovered from used EV batteries. The majority of Brunp's output feeds directly back into CATL's battery manufacturing processes. The overall goal is to create new forms of value while reducing exposure to supply disruptions and the risks of material price volatility. The implementation of these practices has led to several positive outcomes. CATL-Brunp has extended battery lifespan, scaled up material recovery and recycling, and reduced reliance on virgin minerals. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, CATL-Brunp faces several challenges and barriers. These include the need for ongoing investment in recycling

infrastructure, the potential for fluctuations in the supply of used EV batteries, and the need for international harmonization of battery recycling standards. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, CATL-Brunp has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the design of the batteries to the recycling of the materials.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at CATL-Brunp. These include:

- Designing batteries with materials that are less environmentally harmful and easier to recycle.
- Implementing closed-loop manufacturing processes to minimize waste and maximize resource efficiency.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Optimizing the supply chain to reduce transportation costs and greenhouse gas emissions.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, CATL-Brunp can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable battery design, closed-loop manufacturing processes, and supply chain optimization, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 9: Yan'antang (China)

“Reducing plastic waste in cosmetics through tech innovation: Yan An Tang”

Yan An Tang (YAT) provides a compelling example of how to reduce plastic waste in the cosmetics industry through tech innovation, demonstrating the potential for integrating circular economy principles with waste management, e-commerce, and data analytics. This case highlights several key aspects relevant to the research objectives. First, YAT addresses the challenge of increasing plastic waste in the Chinese beauty and cosmetics market by offering consumers an alternative to throwing away empty cosmetic bottles. By recovering these bottles for post-consumer recycling (PCR) and using a mini-app embedded within WeChat to facilitate the collection process, YAT showcases how circular economy principles can be applied to overcome these challenges and create positive social,

economic, and environmental outcomes. The YAT's approach incorporates several eco-innovation strategies. By using a sharing recycling infrastructure, YAT makes the process of returning used packaging more convenient for users. The company also uses image recognition technology and robotic arms for automated material sorting, streamlining the sorting process and improving material identification accuracy. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the YAT case. The company's innovative use of technology, its focus on building relationships with consumers and beauty brands, and its commitment to recycling standards have been essential to its success. The case also highlights the importance of addressing the root causes of plastic waste and providing consumers with a convenient and affordable way to recycle their empty cosmetic bottles. The business implications of YAT's approach are also noteworthy. The company has been able to increase recycling rates, reduce plastic waste, and provide beauty brands with valuable data on consumer recycling behavior. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Yan An Tang (YAT) is a Chinese cosmetic company that offers its users an alternative to throwing away empty cosmetic bottles by recovering them for post-consumer recycling (PCR). YAT has launched its platform, 'Diary Recycle', which works through a mini-app embedded within WeChat. To send their empty packaging, users must register with their phone and WeChat number and request a collection. Once an order has been collected and received at a warehouse in Suzhou, YAT handles sorting, cleaning, disassembly, crushing, and granulating the empty cosmetic bottles, producing PCR content that can be

incorporated back into new products. The overall goal is to minimize waste and increase recycling rates. The implementation of these practices has led to several positive outcomes. YAT has recycled nearly 750,000 cosmetic bottles, reduced plastic waste, and provided beauty brands with valuable data on consumer recycling behavior. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, YAT faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the mini-app, the potential for fluctuations in the supply of empty cosmetic bottles, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, YAT has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the production of the mini-app to the recycling of the plastic bottles.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at YAT. These include:

- Implementing sustainable software development practices to reduce the energy consumption and environmental impact of the mini-app.

- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Using electric vehicles for collection to reduce greenhouse gas emissions and air pollution.
- Using compostable packaging materials for the collection and transportation of the empty cosmetic bottles.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, YAT can further enhance its environmental sustainability in several ways:

- **Reduced Environmental Footprint:** Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- **Increased Resource Efficiency:** By implementing sustainable app development practices, transitioning to renewable energy sources, and using electric vehicles for collection, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- **Climate Change Mitigation:** By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- **Inclusive Economic Development:** By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 10: Enhancing the quality of resale: Déjà Vu

“Enhancing the quality of resale: Déjà Vu”

Déjà Vu provides a compelling example of how to enhance the quality of resale, demonstrating the potential for integrating circular economy principles with e-commerce, quality assurance, and consumer behavior. This case highlights several key aspects relevant to the research objectives. First, Déjà Vu addresses the challenges of perceived low quality and inconsistent supply that are often associated with ‘second-hand’ sales in China by establishing a digitally efficient reuse marketplace that aims to provide its customers with confidence and convenience. By including services to maintain quality through repair, cleaning, and refurbishment, Déjà Vu's model extends the lifespan of the products it sells, ensuring that the materials embedded within them are circulated at their highest value for as long as possible, minimizing waste. The Déjà Vu's approach incorporates several eco-innovation strategies. By using an algorithm that tracks demand and quality to offer transparent pricing, Déjà Vu overcomes the typical challenges of perceived low quality and inconsistent supply. The company also uses a WeChat mobile app that allows buyers to scan the ISBN to view quality standards and estimated purchase prices. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Déjà Vu case. The company's focus on quality assurance, its use of technology to provide transparency and convenience, and its commitment to circular design have been essential to its success. The case also highlights the importance of addressing the root causes of consumer concerns about second-hand products and providing a reliable and trustworthy platform for buying and selling used goods. The business implications of Déjà Vu's approach are also

noteworthy. The company has been able to gain a following of 12 million users, resell millions of used books and clothing items, and reduce the number of new courier boxes needed on a monthly basis. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Déjà Vu is a second-hand trading platform that specializes in selling refurbished books, clothing, and small electronics. The business has established a digitally efficient reuse marketplace that aims to provide its customers with confidence and convenience. Déjà Vu uses an algorithm that tracks demand and quality to offer transparent pricing. A free courier service collects the product from the seller, and once received by the nearest Déjà Vu warehouse, each book is manually repaired and reconditioned by ozone sterilization. The overall goal is to enhance the quality of resale and promote the reuse of products. The implementation of these practices has led to several positive outcomes. Déjà Vu has gained a following of 12 million users, resold millions of used books and clothing items, and reduced the number of new courier boxes needed on a monthly basis. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Déjà Vu faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the platform, the potential for fluctuations in the supply of used goods, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, Déjà Vu has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the collection of the used goods to the delivery of the refurbished products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Déjà Vu. These include:

- Using sustainable packaging materials for the delivery of the refurbished products.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Using electric vehicles for delivery to reduce greenhouse gas emissions and air pollution.
- Developing innovative ways to valorize waste materials generated during the refurbishment process, such as converting them into compost or biochar.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Déjà Vu can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable packaging, transitioning to renewable energy sources, and using electric vehicles for delivery, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.

- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 11: Saving office furniture from landfill: Deartree

“Saving office furniture from landfill: Deartree”

Deartree provides a compelling example of how to save office furniture from landfill, demonstrating the potential for integrating circular economy principles with waste management, B2B commerce, and supply chain optimization. This case highlights several key aspects relevant to the research objectives. First, Deartree addresses the challenge of office furniture waste by refurbishing mid-to-high-end office chairs, desks, and cabinets recovered from medium-to-large-sized enterprises. By providing more than 130,000 buyers with second-hand office furniture, Deartree showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Deartree's approach incorporates several eco-innovation strategies. By creating a cost-effective supply network to enable reverse flows of office furniture at scale, Deartree ensures that the embodied value in the materials that go into making these desks and chairs is utilized to its full potential. The company also uses a ‘Circular Office System’ (COS) digital management system to track its entire process from demand and sales, to collection, storage, and delivery. This integrated

approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Deartree case. The company's focus on quality assurance, its use of technology to optimize its supply chain, and its commitment to providing a cost-effective solution have been essential to its success. The case also highlights the importance of addressing the root causes of office furniture waste and providing businesses with a convenient and affordable way to dispose of their unwanted furniture. The business implications of Deartree's approach are also noteworthy. The company has been able to circulate hundreds of thousands of pieces of furniture, reduce carbon emissions, and save buyers significant procurement costs. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Deartree was founded to ensure that office furniture has multiple lives by refurbishing mid-to-high-end office chairs, desks, and cabinets recovered from medium-to-large-sized enterprises. This business-to-business (B2B) network has provided more than 130,000 buyers with second-hand office furniture so far. Companies can contact Deartree directly through its in-house 'Furniture Concierge' service and a team will collect and transport furniture to a warehouse. Following in-house quality, condition, and safety classification assessments, recovered items are resold with new warranties provided by Deartree. The overall goal is to reduce waste and promote the reuse of office furniture. The implementation of these practices has led to several positive outcomes. Deartree has circulated hundreds of thousands of pieces of furniture, reduced carbon emissions, and saved buyers significant procurement costs. These results demonstrate the potential for

innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Deartree faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the COS system, the potential for fluctuations in the supply of used office furniture, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, Deartree has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the collection of the used furniture to the delivery of the refurbished products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Deartree. These include:

- Using alternative fuels or electric vehicles for the collection and delivery of furniture.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Implementing strategies to reduce waste generated during the refurbishment process, such as recycling or composting materials.

- Using sustainable materials for repairs and refurbishments, such as recycled or bio-based materials.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Deartree can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable transportation, transitioning to renewable energy sources, and using sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 12: China's policies to advance vehicle remanufacturing

“China's policies to advance vehicle remanufacturing”

China's policies to advance vehicle remanufacturing provide a compelling example of how government intervention can drive the circular economy, demonstrating the potential for integrating circular economy principles with industrial policy, waste management, and

economic development. This case highlights several key aspects relevant to the research objectives. First, China has adopted the circular economy as a national priority since the late 2000s and defined vehicle remanufacturing as a strategic sector. Over the last decade, three key policies have propelled the growth of the vehicle remanufacturing sector in China: financial incentives, industrial clusters, and funding for technological advancement and standards. By implementing these policies, China showcases how government intervention can be applied to overcome challenges and create positive social, economic, and environmental outcomes. The Chinese government's approach incorporates several eco-innovation strategies. By providing subsidies for enterprises that collect vehicles and component parts, the government has increased collection rates. By offering consumers a 10% discount on remanufactured parts, the government has incentivized the purchase of remanufactured products. By establishing industrial zones, the government has enabled enterprises to exchange information and best practices. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Chinese government's approach. The government's commitment to the circular economy, its willingness to experiment with pilot projects, and its focus on collaboration among key actors have been essential to its success. The case also highlights the importance of addressing the root causes of waste and promoting the reuse of materials. The business implications of the Chinese government's approach are also noteworthy. The government has been able to reduce waste, promote economic growth, and create new jobs. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

China has adopted the circular economy as a national priority since the late 2000s and defined vehicle remanufacturing as a strategic sector. Over the last decade, three key policies have propelled the growth of the vehicle remanufacturing sector in China: financial incentives, industrial clusters, and funding for technological advancement and standards. The overall goal is to achieve resource circulation and reduce pollution. The implementation of these policies has led to several positive outcomes. China has increased collection rates, incentivized the purchase of remanufactured products, and enabled enterprises to exchange information and best practices. These results demonstrate the potential for government intervention to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, the Chinese government faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the policies, the potential for unintended consequences, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the government's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy policies, the Chinese government has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the collection of the used vehicles to the sale of the remanufactured products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation in the Chinese government's policies. These include:

- Providing incentives for the use of alternative fuels or electric vehicles for the collection and delivery of vehicles and component parts.
- Providing incentives for the use of renewable energy sources, such as solar and wind, to power the remanufacturing facilities.
- Implementing policies to reduce waste generated during the remanufacturing process, such as recycling or composting materials.
- Providing incentives for the use of sustainable materials for repairs and refurbishments, such as recycled or bio-based materials.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, the Chinese government can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the government's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable transportation, transitioning to renewable energy sources, and using sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 13: Durable, ‘timeless’ products in small collections: klee klee

“Durable, ‘timeless’ products in small collections: klee klee”

klee klee provides a compelling example of how to design durable, 'timeless' products in small collections, demonstrating the potential for integrating circular economy principles with sustainable design, responsible manufacturing, and consumer engagement. This case highlights several key aspects relevant to the research objectives. First, klee klee addresses the challenges of fast fashion by designing products to last and using safe materials with low environmental impact. By offering free repair services and recycling programs, klee klee showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The klee klee's approach incorporates several eco-innovation strategies. By focusing on timeless designs, klee klee empowers its customers to use their products more and for longer. By using organic materials and low-impact manufacturing processes, klee klee reduces energy and water consumption while avoiding pollution. By sharing stories about the products and the fabrics with its customers, klee klee inspires emotional connection with the clothes. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the klee klee case. The company's commitment to sustainable design, its focus on responsible manufacturing, and its dedication to consumer engagement have been essential to its success. The case also highlights the importance of addressing the root causes of fast fashion and providing consumers with a sustainable alternative. The business implications of klee klee's approach are also noteworthy. The company has been able to build a loyal

customer base, reduce its environmental impact, and promote a more sustainable lifestyle. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

The klee klee is a Shanghai-based fashion label defined by its minimalist aesthetic and environmentally conscious principles. With a dedication to reducing environmental impact, the brand utilizes organic materials and low impact manufacturing processes, crafting a low-impact production chain. klee klee offers free repair services on all their clothes and a tailoring service for customers to request adjustments for fitting. The overall goal is to promote a "slow-living" attitude and reconnect people to the harmonious rhythm of nature. The implementation of these practices has led to several positive outcomes. klee klee has empowered its customers to use their products more and for longer, reduced energy and water consumption, and inspired emotional connection with the clothes. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, klee klee faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the brand, the potential for fluctuations in the supply of organic materials, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, klee klee has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the design of the clothes to the end-of-life management of the garments.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at klee klee. These include:

- Designing clothes with materials that are less environmentally harmful and easier to recycle.
- Implementing closed-loop manufacturing processes to minimize waste and maximize resource efficiency.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Optimizing the supply chain to reduce transportation costs and greenhouse gas emissions.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, klee klee can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.

- By implementing sustainable design, closed-loop manufacturing processes, and supply chain optimization, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Potential Challenges and Barriers to Eco-Innovation: Integrating eco-innovation at klee klee would also present challenges and barriers. These include limited access to finance for eco-innovation projects, a lack of technical expertise and skills, regulatory hurdles, and market barriers. Additionally, the need for collaboration and partnerships among various stakeholders, including governments, businesses, research institutions, and civil society organizations, is crucial for successful eco-innovation.

Case Study – 14: Enabling cashmere to be used for longer: ERDOS

“Enabling cashmere to be used for longer: ERDOS”

ERDOS provides a compelling example of how to enable cashmere to be used for longer, demonstrating the potential for integrating circular economy principles with post-sales services, material innovation, and consumer engagement. This case highlights several key aspects relevant to the research objectives. First, ERDOS addresses the challenges of

cashmere production by offering cleaning, maintenance, and repair services to their member customers. By introducing the 'Sweater reborn service', ERDOS showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The ERDOS's approach incorporates several eco-innovation strategies. By advocating sustainable consumption with its post-sales care services, ERDOS helps customers learn the way of maintenance. By offering the 'Sweater reborn service', ERDOS aims to upgrade products and services, which not only generate affection and innovative value to the cashmere clothes, but also meet the customers' demand for quality. By completing a Life Cycle Assessment for its products in China and adopting a series of measures to effectively control pollution and waste from the production process, ERDOS balances environmental protection and economic development. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the ERDOS case. The company's commitment to sustainable consumption, its focus on post-sales services, and its dedication to material innovation have been essential to its success. The case also highlights the importance of addressing the root causes of cashmere production and providing consumers with a sustainable alternative. The business implications of ERDOS's approach are also noteworthy. The company has been able to build a loyal customer base, reduce its environmental impact, and promote a more sustainable lifestyle. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

ERDOS Group has established the ERDOS Cashmere Care Center in Beijing and several major cities to offer cleaning, maintenance, and repair services to their member customers. ERDOS brands are promoting various other sustainability programs. ERDOS 1980 introduced the 'Sweater reborn service' in 2018. The overall goal is to increase the utilization rate of cashmere through the industrial chain. The implementation of these practices has led to several positive outcomes. ERDOS has helped customers learn the way of maintenance, upgraded products and services, and met the customers' demand for quality. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, ERDOS faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the brand, the potential for fluctuations in the supply of cashmere, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, ERDOS has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the production of the cashmere to the end-of-life management of the garments.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at ERDOS. These include:

- Sourcing cashmere from farms that use sustainable grazing practices.
- Implementing closed-loop manufacturing processes to minimize waste and maximize resource efficiency.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Optimizing the supply chain to reduce transportation costs and greenhouse gas emissions.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, ERDOS can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop manufacturing processes, and supply chain optimization, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 15: Protecting resources by recycling precious metals: GEM

“Protecting resources by recycling precious metals: GEM”

GEM provides a compelling example of how to protect resources by recycling precious metals, demonstrating the potential for integrating circular economy principles with waste management, resource recovery, and industrial ecology. This case highlights several key aspects relevant to the research objectives. First, GEM addresses the challenges of electronic waste and battery waste by collecting and recycling precious metals and other valuable materials from discarded batteries and electronics. By operating in 16 circular industrial hubs and using advanced technology to extract valuable resources, GEM showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The GEM's approach incorporates several eco-innovation strategies. By keeping materials in use, GEM avoids the creation of toxic waste and conserves valuable resources. By recycling scrapped lithium batteries from EVs, GEM extracts nickel, cobalt, and other important resources, transforming them into components used by battery producers. By leading the high-tech recycling market in China, GEM demonstrates the potential for recycling to contribute to a more circular economy. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the GEM case. The company's commitment to recycling, its focus on technological innovation, and its dedication to resource recovery have been essential to its success. The case also highlights the importance of addressing the root causes of electronic waste and battery waste and providing a sustainable solution for managing these materials. The business implications of GEM's approach are also noteworthy. The company has been

able to recycle millions of tons of electronic waste, reduce carbon dioxide emissions, and recover valuable resources. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

GEM Co. Ltd (GEM) collects and recycles precious metals and other valuable materials from discarded batteries and electronics. GEM operates in 16 circular industrial hubs used for the recycling of waste batteries, discarded electronics and scrapped cars. GEM's technology enables the recycling of scrapped lithium batteries from EVs, extracting nickel, cobalt and other important resources, transforming them into components used by battery producers. The overall goal is to keep materials in use, avoiding the creation of toxic waste, and conserving valuable resources. The implementation of these practices has led to several positive outcomes. GEM has recycled millions of tons of electronic waste, reduced carbon dioxide emissions, and recovered valuable resources. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, GEM faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the recycling facilities, the potential for fluctuations in the supply of electronic waste and battery waste, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, GEM has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the collection of the waste materials to the sale of the recovered resources.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at GEM. These include:

- Implementing sustainable collection practices to minimize transportation costs and greenhouse gas emissions.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Implementing strategies to reduce waste generated during the recycling process, such as recycling or composting materials.
- Using sustainable materials for repairs and refurbishments, such as recycled or bio-based materials.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, GEM can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable collection, transitioning to renewable energy sources, and using sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.

- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 16: Working with nature to make food last longer: Apeel

“Working with nature to make food last longer: Apeel”

Apeel provides a compelling example of how to work with nature to make food last longer, demonstrating the potential for integrating circular economy principles with food technology, waste reduction, and sustainable agriculture. This case highlights several key aspects relevant to the research objectives. First, Apeel addresses the challenges of food waste and plastic packaging by developing an innovative way to eliminate single-use shrink wrap plastic packaging on fresh fruit and veg, while at the same time tackling food waste. By mimicking and enhancing the natural defenses of fruit and vegetables, Apeel slows down the two main things that cause spoilage – water loss and oxidation. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Apeel's approach incorporates several eco-innovation strategies. By designing out food waste, plastic waste, and energy and resource waste, Apeel drives key principles of the circular economy. By using the building blocks that exist in the peels, seeds, and pulp of all fruits and vegetables, Apeel creates a layer of edible, plant-based coating that keeps moisture inside the food and

keeps oxygen out. By making it possible for growers to avoid harvesting before ripeness, Apeel allows fruit and vegetables to develop to their full quality before they begin the journey to supermarkets and supply outlets. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Apeel case. The company's commitment to innovation, its focus on natural solutions, and its dedication to waste reduction have been essential to its success. The case also highlights the importance of addressing the root causes of food waste and plastic packaging and providing a sustainable alternative. The business implications of Apeel's approach are also noteworthy. The company has been able to reduce food waste, eliminate plastic packaging, and promote better quality food. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Apeel is a company that has come up with an innovative way to eliminate single-use shrink wrap plastic packaging on fresh fruit and veg, while at the same time tackling food waste. Apeel is a layer of edible, plant-based coating applied to fresh products that mimics and enhances the natural defenses of fruit and vegetables. This slows down the two main things that cause spoilage – water loss and oxidation. The overall goal is to increase the shelf life of fresh produce. The implementation of these practices has led to several positive outcomes. Apeel has reduced food waste, eliminated plastic packaging, and promoted better quality food. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Apeel faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the coating, the potential for fluctuations in the supply of fruits and vegetables, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, Apeel has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the plant-based materials to the end-of-life management of the coating.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Apeel. These include:

- Sourcing the plant-based materials from farms that use sustainable agricultural practices.
- Implementing closed-loop manufacturing processes to minimize waste and maximize resource efficiency.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Optimizing the supply chain to reduce transportation costs and greenhouse gas emissions.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Apeel can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop manufacturing processes, and supply chain optimization, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 17: Japan’s disclosure and engagement guidance: facilitating transition to a circular economy through finance (Japan)

“Japan’s disclosure and engagement guidance: facilitating transition to a circular economy through finance”

Japan's disclosure and engagement guidance provides a compelling example of how to facilitate the transition to a circular economy through finance, demonstrating the potential for integrating circular economy principles with investment decisions and corporate strategies. This case highlights several key aspects relevant to the research objectives. First,

the guidance addresses the challenge of attracting foreign and domestic investments into circular activities by providing companies with a framework for communicating their circular economy activities and innovative technologies to investors. By using existing financial frameworks and embedding circular economy considerations into business strategies, the Japanese government showcases how policy can be used to overcome these challenges and create positive social, economic, and environmental outcomes. The guidance's approach incorporates several eco-innovation strategies. By encouraging companies to comprehensively communicate their values, business models, strategies, and governance to investors, the guidance promotes transparency and accountability. The guidance also helps investors incorporate circular economy considerations into their engagement and stewardship activities with companies. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Japan's disclosure and engagement guidance case. The guidance's government leadership, its focus on providing companies with a clear framework for disclosure and engagement, and its alignment with existing financial frameworks have been essential to its success. The case also highlights the importance of collaboration among government agencies, companies, financial institutions, research institutions, and academics. The business implications of the guidance's approach are also noteworthy. The guidance can help companies de-risk investments, drive superior risk-adjusted returns, and tap into new sources of long-term growth and value creation. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Japan's disclosure and engagement guidance is a government-formulated guidance on disclosure and engagement that specifically targets the circular economy. The guidance encourages companies to communicate to investors how, through their circular economy activities and innovative technologies, they can provide return on investments. The overall goal is to unlock more investment in the circular economy. The implementation of this guidance can help companies embed circular economy thinking into their business strategies, activities, and decisions, and scale circular economy innovations and technologies. These results demonstrate the potential for policy to drive the transition to a circular economy.

Potential Challenges and Barriers: Despite the potential benefits, Japan's disclosure and engagement guidance faces several challenges and barriers. These include the need for ongoing monitoring and evaluation, the potential for companies to engage in greenwashing, and the need for international harmonization of circular economy disclosure standards. Additionally, regulatory hurdles and market barriers could hinder the adoption of circular economy practices.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing disclosure and engagement guidance, Japan has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on developing and implementing innovative solutions that address specific environmental challenges and promote sustainable economic development.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation in Japan's disclosure and engagement guidance. These include:

- Encouraging companies to design products and services that are durable, repairable, recyclable, and reusable.
- Promoting the adoption of circular business models, such as product-as-a-service, leasing, and sharing, that reduce resource consumption and extend product lifecycles.
- Encouraging companies to invest in technologies that can convert waste materials into valuable products, such as biochar, compost, and energy.
- Implementing data analytics and artificial intelligence (AI) to monitor the environmental performance of companies and identify opportunities for improvement.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Japan can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the overall environmental footprint of economic activities by minimizing resource consumption, waste generation, and pollution.
- By promoting eco-design, supporting circular business models, and investing in waste valorization technologies, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.

- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 18: Kecipir, part of Enviu (Indonesia)

“Eliminating plastic and reducing food costs: Kecipir, part of Enviu”

Kecipir provides a compelling example of how to eliminate plastic and reduce food costs through a farm-to-fork app, demonstrating the potential for integrating circular economy principles with sustainable agriculture, e-commerce, and waste reduction. This case highlights several key aspects relevant to the research objectives. First, Kecipir addresses the challenges of plastic waste and food waste in the Indonesian market by connecting fruit and vegetable farmers directly with urban consumers via a plastic-free, circular delivery system. By implementing an organic farming system, meeting quality and quantity standards, and committing to zero waste packaging, Kecipir showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The company's approach incorporates several eco-innovation strategies. By using reusable packaging, Kecipir eliminates single-use plastic waste. The company also reduces food waste by shortening the time from harvest to delivery and reducing the number of stages in the supply chain. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Kecipir case. The company's innovative use of a farm-to-fork app, its focus on building relationships with local farmers, and its commitment to zero waste packaging have been essential to its

success. The case also highlights the importance of addressing the root causes of plastic waste and food waste and providing consumers with a convenient and affordable way to access fresh, organic produce. The business implications of Kecipir's approach are also noteworthy. The company has been able to increase farmer profits, reduce plastic waste, and provide consumers with better and fresher produce at a lower cost. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Kecipir is an app operating in the Indonesian market that connects fruit and vegetable farmers directly with urban consumers via a plastic-free delivery system. Kecipir customers can access a food webstore via the app to order and pay for their fresh food products. Farmers then harvest the produce, while Kecipir takes care of the packaging, sorting, and distribution. The overall goal is to eliminate plastic waste, reduce food costs, and support local farmers. The implementation of these practices has led to several positive outcomes. Kecipir has eliminated single-use packaging, reduced food waste, increased farmer profits, and provided consumers with better and fresher produce at a lower cost. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Kecipir faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the app, the potential for fluctuations in crop yields and market demand, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, Kecipir has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the production of the app to the delivery of the fresh produce.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Kecipir. These include:

- Implementing sustainable software development practices to reduce the energy consumption and environmental impact of the app.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations and reduce reliance on fossil fuels.
- Using electric vehicles for delivery to reduce greenhouse gas emissions and air pollution.
- Using compostable packaging materials for the fresh produce to further reduce waste and promote soil health.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Kecipir can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.

- By implementing sustainable app development practices, transitioning to renewable energy sources, and using electric vehicles for delivery, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help farmers adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 19: Community Managed Natural Farming (India)

“Greater resilience for smallholder farmers: Community Managed Natural Farming”

Community Managed Natural Farming (CMNF) provides a compelling example of how to build greater resilience for smallholder farmers, demonstrating the potential for integrating circular economy principles with sustainable agriculture, climate resilience, and economic development. This case highlights several key aspects relevant to the research objectives. First, CMNF addresses the challenges of farmer debt, soil degradation, and climate vulnerability by promoting a set of agroecological farming methods that eliminate the need for costly inputs and restore soil health. By applying the four principles of Beejamrutham, Jeevamrutham, Achhadana, and Waaphasa, CMNF showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The CMNF's approach incorporates several eco-innovation strategies. By reducing costs, increasing yields, and improving resilience to

climate shocks, CMNF empowers farmers to improve their livelihoods and build more sustainable farming systems. The program also prevents exposure to harmful chemicals, reducing health risks and medical costs. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the CMNF case. The program's focus on reducing farmer debt, its emphasis on restoring soil health, and its ability to increase resilience to climate change have been essential to its success. The case also highlights the importance of grassroots movements, such as women's self-help groups, in promoting sustainable agriculture practices. The business implications of CMNF's approach are also noteworthy. The program has been able to improve food security, increase farmer profits, and reduce exposure to harmful chemicals. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Community Managed Natural Farming (CMNF) is a set of agroecological farming methods that originated in the State of Karnataka, India. The aim was to establish an approach to farming that could decouple smallholder farmers from the risk of debt associated with the high costs of seeds, fertilisers, and other inputs. The overall goal is to reduce costs, increase yields, improve resilience, and promote sustainable agriculture. The implementation of these practices has led to several positive outcomes. CMNF has reduced farmer debt, increased yields, improved resilience to climate shocks, and prevented exposure to harmful chemicals. These results demonstrate the potential for sustainable agriculture practices to address agricultural, environmental, and economic challenges.

Potential Challenges and Barriers: Despite the positive results, CMNF faces several challenges and barriers. These include the need for ongoing training and support, the potential for resistance from farmers who are accustomed to conventional farming practices, and the need for access to markets and infrastructure. Additionally, regulatory hurdles and trade barriers could hinder the adoption of CMNF practices.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing Natural Farming practices, CMNF has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on developing and implementing innovative solutions that address specific environmental challenges and promote sustainable economic development.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at CMNF. These include:

- Implementing precision agriculture technologies to optimize resource use, reduce waste, and improve crop yields.
- Transitioning to renewable energy sources, such as solar and biogas, to power farm operations and reduce reliance on fossil fuels.
- Developing innovative ways to valorize agricultural waste, such as converting it into compost, biochar, or biogas.
- Utilizing data analytics and artificial intelligence (AI) to monitor farm performance, optimize resource allocation, and improve decision-making.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, CMNF can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the overall environmental footprint of agricultural activities by minimizing resource consumption, waste generation, and pollution.
- By implementing precision agriculture technologies, transitioning to renewable energy sources, and valorizing agricultural waste, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and sequestering carbon in the soil, eco-innovation can contribute to climate change mitigation and help farmers adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

3.5 Case Studies in Europe and Their Results

In Europe, five case studies are considered. Analysis of each case study in the context of without eco-innovation and with eco-innovation integration is given below.

Case Study – 20: Using material substitution to reduce and capture carbon: HAUT

“Using material substitution to reduce and capture carbon: HAUT”

HAUT, a timber-hybrid building in Amsterdam, provides a compelling example of how material substitution can significantly reduce carbon emissions in the built environment. This case highlights several key aspects relevant to the research objectives. First, it demonstrates the potential for using timber as a primary structural material to lower embodied emissions compared to concrete and steel. By using timber, HAUT achieves a 50% reduction in carbon emissions compared to a conventional building and stores approximately 1,800 tonnes of CO₂. This showcases how material substitution can be a powerful strategy for mitigating climate change in the construction sector. HAUT's approach incorporates several eco-innovation strategies. By using timber, the building benefits from less energy-intensive production processes, lighter structures, and direct carbon sequestration. The lighter floor plates enable more efficient truck loading, resulting in fewer deliveries to the building site. Employing off-site/prefabricated construction techniques allows construction workers to operate in safer environments. The building's BREEAM Outstanding certification further demonstrates its commitment to sustainability. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the HAUT case. The Netherlands' commitment to achieving climate neutrality by 2050, with Amsterdam pledging to construct at least one in five residential buildings using timber, created a supportive policy environment. The use of timber structure enhances the atmosphere and acoustics of buildings, making it an attractive alternative to conventional materials. The building's BREEAM Outstanding certification provides a credible validation of its sustainability performance. The economic and environmental implications of HAUT are also noteworthy. By reducing carbon emissions and promoting the use of sustainable materials, the building is contributing to climate change mitigation and promoting a more circular economy. This suggests that adopting material substitution

strategies can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the built environment.

Without Explicit Eco-Innovation

The Netherlands has committed to achieving climate neutrality by 2050, with Amsterdam pledging to construct at least one in five residential buildings using timber as the primary structural material from 2025. Completed in Amsterdam in 2022, HAUT's 21 floors positions the development as one of the tallest timber hybrid buildings in the world. By using timber, HAUT achieves a 50% reduction in carbon emissions compared to a conventional building, and the building stores approximately 1,800 tonnes of CO₂ when taking into account sequestration.

Potential Challenges and Barriers: Despite the positive results, HAUT faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the timber structure, the potential for resistance from the construction industry, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the building's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, HAUT has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at HAUT. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the building's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, HAUT can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the building's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 21: EU's Innovation Deal for a circular economy

“EU's Innovation Deal for a circular economy”

The EU's Innovation Deal for a circular economy provides a valuable example of how public-private collaboration can address regulatory barriers and foster circular solutions. This case highlights several key aspects relevant to the research objectives. First, it demonstrates the potential for electric vehicle (EV) batteries to provide multiple environmental benefits across various use-cycles, including decarbonization, pollution reduction, and energy storage. By repurposing EV batteries, innovators can prevent waste, limit the extraction of critical raw materials, and offset CO₂ emissions. This showcases how innovation can drive circularity and achieve broader sustainability goals. The EU's approach incorporates several eco-innovation strategies. By identifying Innovation Deals as a mechanism to stimulate innovation and support the transition towards a circular economy, the EU is creating a supportive policy environment. By selecting pilot projects to help innovators overcome potential regulatory barriers, the EU is fostering the development and scaling of circular solutions. By facilitating collaboration between innovators, public authorities, and the European Commission, the EU is promoting knowledge sharing and problem-solving. By reflecting insights from innovators in the proposed revision of the EU Battery Directive, the EU is ensuring that legislation keeps up with technological developments. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the EU's Innovation Deal. The European Commission's commitment to fostering innovation and supporting the transition towards a circular economy was essential to its success. The collaboration between innovators from

the automotive industry, Dutch and French public authorities, and the European Commission was also crucial. The case also highlights the importance of identifying and addressing regulatory barriers to innovation. The economic and environmental implications of the EU's Innovation Deal are also noteworthy. By encouraging the reuse of EV batteries as energy storage devices and designing an energy market that would enable innovations to scale, the EU is promoting a more circular and sustainable economy. This suggests that adopting a collaborative, multi-stakeholder approach to circular innovation can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the EU.

Without Explicit Eco-Innovation

In the 2015 EU Action Plan for the Circular Economy, Innovation Deals were identified as a mechanism to stimulate innovation and support the transition towards a circular economy. The European Commission selected two Innovation Deals out of 32 project proposals as pilots to help innovators with promising circular solutions to overcome potential regulatory barriers and bring their ideas to the market. The “From E-Mobility to recycling: the virtuous loop of the electric vehicle” Innovation Deal brought innovators from the automotive industry together with, the Dutch and French public authorities, and the European Commission. In its reports, the consortium put forward recommendations to encourage the reuse of EV batteries as energy storage devices and design an energy market that would enable innovations to scale. Insights from innovators were reflected in the European Commission's 2020 proposed revision of the EU Battery Directive, which aims to ensure long-lasting and safe batteries that are repurposed, remanufactured or recycled at their end of life.

Potential Challenges and Barriers: Despite the positive results, the EU faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the Innovation Deal process, the potential for resistance from stakeholders, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the EU's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, the EU has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at the EU. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the EU's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, the EU can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the EU's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 22: An industry wide shared packaging system: Swedish Return System

“An industry wide shared packaging system: Swedish Return System”

The Swedish Return System (SRS) provides a compelling example of how an industry-wide shared packaging system can significantly reduce waste and promote circularity. This case highlights several key aspects relevant to the research objectives. First, it demonstrates the potential for replacing a fragmented model of single-use packaging with a reusable system, where crates and pallets can be used over and over again. By cycling 150 million crates and 8 million pallets through the system in 2019, SRS significantly reduced

packaging waste generated by the grocery industry. This showcases how collaborative initiatives can drive circularity and achieve broader sustainability goals. SRS's approach incorporates several eco-innovation strategies. By using robust and lightweight crates and pallets, the system protects produce from damage, lowers transport costs, and increases ease of handling. By standardizing the design of the crates, SRS optimizes business operations and allows for accurate calibration of packaging systems. By eliminating the need for unpacking, the system reduces labor in a typical store by 160 hours each year. By recycling old crates into new ones, SRS ensures that the system remains circular. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the SRS case. The industry-wide collaboration between the Trade Association for Grocery of Sweden and the Swedish Food and Drinks Retailers Association was essential to its success. The high-quality standardized design of the crates, which brings many business benefits to producers and retailers, was also crucial. The case also highlights the importance of durability, as the crates last an average of 15 years. The economic and environmental implications of SRS are also noteworthy. By eliminating 50,000 tonnes of material waste and reducing greenhouse gas emissions by 78% each year, SRS is contributing to a more circular and sustainable economy. This suggests that adopting a collaborative, standardized approach to reusable packaging can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the food and drinks industry.

Without Explicit Eco-Innovation

The Swedish Return System (SRS) is a shared system of reusable crates and pallets used by the country's food and drinks industry. The B2B system was set up in 1997, and now

has more than 1,500 participating businesses. The result is that over 50% of all fresh produce in Sweden is delivered in reusable packaging. In 2019, 150 million crates and 8 million pallets were cycled through SRS, significantly reducing packaging waste generated by the grocery industry. Each year, in comparison to cardboard packaging, the SRS eliminates 50,000 tonnes of material waste and reduces greenhouse gas emissions by 78%.

Potential Challenges and Barriers: Despite the positive results, SRS faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the system, the potential for resistance from businesses, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the system's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, SRS has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at SRS. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.

- Transitioning to renewable energy sources, such as solar and wind, to power the system's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, SRS can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the system's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 23: Creating trust in the sharing economy: Omocom

“Creating trust in the sharing economy: Omocom”

Omocom provides a compelling example of how innovative insurance solutions can foster trust and enable the sharing economy. This case highlights several key aspects relevant to the research objectives. First, it demonstrates the potential for 'on-demand' microinsurance to address a critical barrier to the sharing economy: the lack of trust and security for those listing their items on peer-to-peer platforms. By providing insurance tailored specifically for rentals, Omocom enables trust and makes the user experience smoother, leading to increased use of existing goods. This showcases how innovative business models can drive circularity and achieve broader sustainability goals. Omocom's approach incorporates several eco-innovation strategies. By developing a risk assessment framework that uses transaction data to prevent fraud and alleviate risk, Omocom makes it safer to share. By integrating its insurance product into existing digital sharing platforms, Omocom makes it easy for users to access and purchase insurance. By offering insurance on an individual transaction basis or on an 'all-in' basis, Omocom provides flexibility and caters to different needs. By focusing on short, well-defined timeframes, Omocom minimizes risk for the reinsurer and makes the insurance more affordable. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the Omocom case. The identification of a well-defined problem that was holding back a clearly growing consumer trend was essential to its success. The development of a risk model that uses transaction data to generate policies automatically was also crucial. The ability to persuade a large insurance broker to underwrite their policies provided credibility and financial backing. The early adoption of the service by sharing platforms like Tiptapp and Hygglo demonstrated its value and attracted new clients. The economic and environmental implications of Omocom are also noteworthy. By enabling increased use of existing goods, Omocom is contributing to a more circular and sustainable economy. This suggests that

adopting an innovative, data-driven approach to insurance can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the sharing economy.

Without Explicit Eco-Innovation

The Swedish company provides insurance for hire goods. But here's the smart bit - they only insure an item while it's being used, transported, accessed, or similar, for a short period of time. Omocom's insurance product is integrated into existing digital sharing platforms. Insurance can be calculated on an individual transaction basis, or on an 'all-in' basis, where all transactions generated by the platform are automatically insured. They also use transaction data to prevent fraud and alleviate risk, making it safer to share.

Potential Challenges and Barriers: Despite the positive results, Omocom faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the system, the potential for resistance from traditional insurance companies, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the system's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, Omocom has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Omocom. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the system's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Omocom can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the system's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 24: Effective water systems for urban circularity: Biopolus

“Effective water systems for urban circularity: Biopolus”

Biopolus provides a compelling example of how decentralized, nature-based solutions can transform urban water systems and promote circularity. This case highlights several key aspects relevant to the research objectives. First, it demonstrates the potential for transitioning cities from linear consumption and waste models to regenerative circular models through the implementation of BioMakeries. These urban metabolic hubs harness clean water, energy, nutrients, and minerals from wastewater and organic waste, showcasing how innovative technologies can drive circularity and achieve broader sustainability goals. Biopolus's approach incorporates several eco-innovation strategies. By using advanced biological engineering, the BioMakeries treat and recycle wastewater while providing a platform for circular urban infrastructure integration. By recovering valuable products such as energy, nutrients, and minerals from organic waste, the system closes and valorizes urban organic waste loops. By designing the BioMakeries to be modular, compact, and odor-free, the system can be seamlessly integrated into any urban environment. By creating additional space for community functions and urban food production, the system enhances the social and environmental benefits of urban areas. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the Biopolus case. The innovative MNR technology, which utilizes a large surface area of biomass to increase the diversity and number of microbial species for highly efficient organic waste biodegradation, is a key driver of its success. The modular and scalable design of the BioMakeries allows for flexibility and adaptability to different urban

contexts. The integration of the BioMakery into the historical monument of the Koningshoeven Trappist Abbey and Brewery demonstrates its ability to blend seamlessly with existing infrastructure. The economic and environmental implications of Biopolus are also noteworthy. By replacing traditional large and smelly wastewater treatment facilities with modular, compact, and odor-free BioMakeries, the system frees up valuable land for redevelopment and reduces environmental impact. This suggests that adopting a decentralized, nature-based approach to water management can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of urban areas.

Without Explicit Eco-Innovation

Biopolus MNR Technology harnesses clean water, energy, nutrients, and minerals from wastewater and organic waste. Modular and fully integrated into the urban environment, BioMakeries treat and recycle wastewater, while also providing a platform for circular urban infrastructure integration, all with a beautiful garden aesthetic. Traditional large and smelly wastewater treatment facilities can be replaced by modular, compact, and odour-free BioMakeries, which free up valuable land for redevelopment, and create a platform where energy, food, and organic waste systems are built around a regenerative and sustainable water cycle.

Potential Challenges and Barriers: Despite the positive results, Biopolus faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the system, the potential for resistance from traditional wastewater treatment providers, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the system's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, Biopolus has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Biopolus. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the system's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Biopolus can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the system's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.

- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

3.6 Case Studies in Latin America and Their Results

In Latin America, seven case studies, two from Chile and five from Brazil are considered. Analysis of each case study in the context of without eco-innovation and with eco-innovation integration is given below.

Case Study – 25: Collaboration for a Shared Action Plan (Chile)

“Chile's Circular Economy Roadmap: collaboration for a shared action plan”

Chile's Circular Economy Roadmap provides a compelling example of how to develop a long-term circular economy strategy through broad collaboration, demonstrating the potential for integrating circular economy principles with policy-making, climate action, and sustainable development. This case highlights several key aspects relevant to the research objectives. First, Chile addresses the challenges of waste and pollution by setting a long-term vision and strategy towards a circular economy that eliminates waste and

pollution, circulates products and materials, and regenerates nature. By involving over 100 stakeholders from the public and private sectors, NGOs, academia, and citizens, Chile showcases how collaboration can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Chilean government's approach incorporates several eco-innovation strategies. By setting clear goals and an action plan, Chile provides a framework for transitioning to a circular economy. By focusing on circular innovation, circular culture, circular regulation, and circular territories, Chile addresses the key pillars of a circular economy. By recognizing the cross-cutting potential of the circular economy to address both the causes and effects of climate change, Chile aligns its circular economy roadmap with its climate action plan. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy policy. Several critical success factors are evident in the Chilean government's approach. The government's leadership, its commitment to collaboration, and its focus on long-term planning have been essential to its success. The case also highlights the importance of addressing the root causes of waste and pollution and providing a clear vision for a circular economy. The policy implications of the Chilean government's approach are also noteworthy. The government has been able to create a shared action plan, set ambitious goals, and engage a wide range of stakeholders. This suggests that adopting a collaborative and strategic approach can lead to effective circular economy policy.

Without Explicit Eco-Innovation

Chile has created a long-term circular economy roadmap through a broad participatory development process that involved over 100 stakeholders from the public and private sectors, NGOs, academia, and citizens. The roadmap sets out a long-term vision and shared action plan, bridging traditional silos. The vision of a regenerative, fair and participatory

circular economy in Chile is supported by goals to create jobs, reduce waste, increase recycling and material productivity, and recover illegal dump sites. The detailed action plan includes upstream and downstream activities to create a robust circular economy innovation system, make circular practices the norm, ensure the regulatory framework supports circularity, and adapt to Chile's 16 regions. The overall goal is to tackle the root causes of waste and pollution. The implementation of these policies has led to several positive outcomes. Chile has set ambitious goals, engaged a wide range of stakeholders, and created a shared action plan. These results demonstrate the potential for government intervention to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, the Chilean government faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the roadmap, the potential for unintended consequences, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the government's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy roadmap, the Chilean government has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the design of products to the end-of-life management of materials.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation in the Chilean government's policies. These include:

- Providing incentives for the design of products that are more durable, repairable, and recyclable.
- Implementing policies to promote closed-loop systems, where materials are continuously recycled and reused.
- Providing incentives for the use of renewable energy sources, such as solar and wind, to power the circular economy.
- Providing incentives for the use of sustainable materials in the production of goods and services.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, the Chilean government can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the government's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable design, closed-loop systems, and sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 26: Algramo (Chile)

“Pay for the product, not the packaging: Algramo”

Algramo provides a compelling example of how to transform the way customers access household products, demonstrating the potential for integrating circular economy principles with innovative dispensing systems, smart packaging, and inclusive business models. This case highlights several key aspects relevant to the research objectives. First, Algramo addresses the challenges of plastic waste and affordability by allowing customers to refill household products by using smart powered dispensing machines and packaging chipped with RFID. By eliminating the need for single-use packaging and selling products at bulk prices, Algramo makes eco-friendly brands accessible to a wider demographic of customers. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Algramo's approach incorporates several eco-innovation strategies. By implementing a refill-on-the-go system, Algramo reduces costs, adapts to user needs, improves user experience, builds brand loyalty, and gathers business intelligence. By using smart dispensers and smart packaging, Algramo enables smart payments and optimizes product offerings. By striving to be both better and cheaper, Algramo makes eco-friendly brands accessible to a wider demographic of customers. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Algramo case. The company's commitment to innovation, its focus on affordability, and its dedication to waste reduction have been essential to its success. The case also highlights the importance of addressing the root causes of plastic waste and making eco-friendly products accessible to all. The

business implications of Algramo's approach are also noteworthy. The company has been able to reduce costs, improve user experience, and build brand loyalty. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Algramo is a system that allows customers to refill household products by using smart powered dispensing machines and packaging chipped with RFID. Customers credit their account through an app and bring their smart packaging to an Algramo dispenser. The machine will recognize the packaging and dispense the right product at a desired quantity without the need for login or payment. The overall goal is to eliminate single-use packaging and make eco-friendly brands accessible to a wider demographic of customers. The implementation of these practices has led to several positive outcomes. Algramo has reduced costs, improved user experience, and built brand loyalty. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Algramo faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the dispensing machines, the potential for fluctuations in the supply of household products, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, Algramo has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the household products to the end-of-life management of the smart packaging.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Algramo. These include:

- Sourcing the household products from companies that use sustainable manufacturing practices.
- Implementing closed-loop systems for the smart packaging, where the packaging is continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the dispensing machines.
- Using sustainable materials for the smart packaging, such as recycled or bio-based plastics.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Algramo can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.

- By implementing sustainable sourcing, closed-loop systems, and sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 27: Natura Brazil (Brazil)

“Creating a regenerative economy in the Amazon Forest: Natura Brazil”

Natura Brazil provides a compelling example of how to create a regenerative economy in the Amazon Forest, demonstrating the potential for integrating circular economy principles with biodiversity conservation, community development, and sustainable business practices. This case highlights several key aspects relevant to the research objectives. First, Natura addresses the challenges of deforestation and biodiversity loss by developing a business model that values the 'standing forest' economy. By sourcing ingredients and materials from the Amazon's rich biodiversity and involving local communities in its supply chain, Natura has helped conserve 2 million hectares of rainforest. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Natura's approach incorporates several eco-innovation strategies. By leveraging traditional community

knowledge and giving value to renewable rainforest ingredients, Natura helps conserve the world's biggest tropical rainforest. By investing in communities' development and providing support for bureaucratic issues, Natura formalizes business partnerships and enhances social and natural capital. By viewing the biodiversity of Brazil as a source of technological innovation, Natura meets the demand for new nature-positive products and gains a competitive advantage. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Natura Brazil case. The company's commitment to biodiversity conservation, its focus on community development, and its dedication to sustainable business practices have been essential to its success. The case also highlights the importance of addressing the root causes of deforestation and biodiversity loss and providing a sustainable alternative. The business implications of Natura's approach are also noteworthy. The company has been able to enhance social and natural capital, gain a competitive advantage, and meet the demand for new nature-positive products. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Natura is South America's largest cosmetic company. Natura produces a huge range of products including soaps, creams, and shampoos, all of which rely on the rich biodiversity of the Amazon for ingredients and materials, as well as the 'bio-intelligence' of the local communities. The company's supply chain includes almost 40 types of 'biodiversity assets' (plant-derived ingredients) and the involvement of about 7000 families. A key element of Natura's business model is the concept of the 'standing forest' economy. The overall goal is to help conserve the Amazon rainforest. The implementation of these practices has led

to several positive outcomes. Natura has helped conserve 2 million hectares of rainforest, enhanced social and natural capital, and gained a competitive advantage. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Natura faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the supply chain, the potential for fluctuations in the supply of rainforest ingredients, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, Natura has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the rainforest ingredients to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Natura. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of rainforest ingredients.
- Implementing closed-loop systems for the packaging, where the packaging is continuously recycled and reused.

- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations.
- Using sustainable materials for the products and packaging, such as recycled or bio-based plastics.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Natura can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 28: HP Brazil & Sinctronics (Brazil)

“Creating a reverse logistics ecosystem: HP Brazil & Sinctronics”

HP Brazil and Sinctronics provide a compelling example of how to create a reverse logistics ecosystem, demonstrating the potential for integrating circular economy principles with design, manufacturing, and supply chain management. This case highlights several key aspects relevant to the research objectives. First, HP and Sinctronics address the challenges of electronic waste by combining HP's outreach capacity to establish a robust reverse logistics scheme with Sinctronics' capacity and expertise to recover and create value out of HP end-of-use electronic equipment. By forming a partnership and exchanging information on practical feasibilities, HP and Sinctronics have been able to reduce collection times by 50%, reduce costs by up to 30%, and reincorporate 97% of the collected materials and components into Sinctronics' supply chains. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The HP and Sinctronics' approach incorporates several eco-innovation strategies. By creating a Recycling and Innovation Center next to the manufacturing site, HP and Sinctronics have been able to understand and re-think the product cycle. By developing a closed loop process for plastics recovered from HP end-of-use products, HP and Sinctronics have been able to create recycled white plastic for use in electronics products. By investing in reverse logistics, recycling facilities, research and development, and reverse supply chains, HP and Sinctronics have been able to create a complete ecosystem for material recovery. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the HP Brazil and Sinctronics case. The companies' commitment to collaboration, their focus on innovation, and their dedication to waste reduction have been essential to their success. The case also highlights the importance of addressing the root causes of electronic waste and providing a sustainable alternative. The business implications of HP and Sinctronics' approach are also noteworthy.

The companies have been able to reduce costs, reduce collection times, and reincorporate materials into their supply chains. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

HP has formed a partnership with Sinctronics, which has facilitated the development of processes to increase the volume of recycled materials into new products and packaging. Sinctronics business objectives seek to generate value by providing a full portfolio of services and solutions that goes from a reverse logistics management system to providing technology that helps incorporate recycled materials into new pieces and parts of IT products. The overall goal is to create a circular economy initiative in the Brazilian electronics sector. The implementation of these practices has led to several positive outcomes. HP and Sinctronics have reduced collection times by 50%, reduced costs by up to 30%, and reincorporated 97% of the collected materials and components into Sinctronics' supply chains. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, HP and Sinctronics face several challenges and barriers. These include the need for ongoing maintenance and improvement of the reverse logistics ecosystem, the potential for fluctuations in the supply of electronic waste, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the companies' ability to expand their operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular business model, HP and Sinctronics have the potential to further enhance their environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the design of the electronic products to the end-of-life management of the materials.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at HP and Sinctronics. These include:

- Designing electronic products that are more durable, repairable, and recyclable.
- Implementing closed-loop systems for the materials used in electronic products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the companies' operations.
- Using sustainable materials in the electronic products, such as recycled or bio-based plastics.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, HP and Sinctronics can further enhance their environmental sustainability in several ways:

- Eco-innovation can help to reduce the companies' overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable design, closed-loop systems, and sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.

- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 29: Belo Horizonte (Brazil)

“Tackling electronic waste and digital poverty in Brazil: Belo Horizonte”

Belo Horizonte's Computer Reconditioning Centre (CRC) provides a compelling example of how to tackle electronic waste and digital poverty, demonstrating the potential for integrating circular economy principles with social inclusion, skills development, and urban sustainability. This case highlights several key aspects relevant to the research objectives. First, Belo Horizonte addresses the challenges of electronic waste and digital exclusion by establishing a government-run electronics remanufacturing facility that repurposes redundant equipment and connects disadvantaged communities with digital products. By training citizens from low-income communities to restore donated IT equipment and providing free access to computers and the internet at digital inclusion sites, Belo Horizonte has been able to reduce electronic waste, build digital knowledge among young people, and increase local employment opportunities. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Belo Horizonte's approach incorporates several eco-innovation strategies. By repurposing redundant equipment, Belo Horizonte

keeps electronics circulating in the economy in high-value uses and out of landfill. By training citizens in basic technological skills, environmental education, and computer remanufacturing, Belo Horizonte fosters digital inclusion and increases local employment opportunities. By operating digital inclusion sites that offer free access to computers and the internet, Belo Horizonte democratizes access to information and helps people with tasks like applying for jobs online and paying bills. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular urban development. Several critical success factors are evident in the Belo Horizonte case. The city government's commitment to digital inclusion, its focus on skills development, and its dedication to waste reduction have been essential to its success. The case also highlights the importance of addressing the root causes of electronic waste and digital exclusion and providing a sustainable and inclusive alternative. The urban development implications of Belo Horizonte's approach are also noteworthy. The city has been able to reduce electronic waste, build digital knowledge among young people, increase local employment opportunities, and democratize access to information. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive urban development outcomes, contributing to the overall sustainability and resilience of the city.

Without Explicit Eco-Innovation

Belo Horizonte's Computer Reconditioning Centre (CRC) is a government established electronics remanufacturing facility that reduces electronic waste and tackles youth unemployment. The programme fosters digital inclusion in low income areas to build digital knowledge among young people, increase local employment opportunities, and scale up activities that keep electronics circulating in the economy in high-value uses and out of landfill. The overall goal is to address electronic waste and digital poverty. The

implementation of these practices has led to several positive outcomes. Belo Horizonte has reduced electronic waste, built digital knowledge among young people, increased local employment opportunities, and democratized access to information. These results demonstrate the potential for government intervention to address environmental and social challenges.

Potential Challenges and Barriers: Despite the positive results, Belo Horizonte faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the CRC, the potential for fluctuations in the supply of donated IT equipment, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the city's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular urban development model, Belo Horizonte has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the design of the IT equipment to the end-of-life management of the materials.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Belo Horizonte. These include:

- Providing incentives for the design of IT equipment that is more durable, repairable, and recyclable.
- Implementing closed-loop systems for the materials used in IT equipment, where the materials are continuously recycled and reused.

- Transitioning to renewable energy sources, such as solar and wind, to power the CRC and digital inclusion sites.
- Using sustainable materials in the IT equipment, such as recycled or bio-based plastics.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Belo Horizonte can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the city's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable design, closed-loop systems, and sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 30: The Balbo Group (Brazil)

“Regenerating an ecosystem to grow organic sugar: The Balbo Group”

The Balbo Group provides a compelling example of how to regenerate an ecosystem to grow organic sugar, demonstrating the potential for integrating circular economy principles with regenerative agriculture, waste valorization, and renewable energy production. This case highlights several key aspects relevant to the research objectives. First, The Balbo Group addresses the challenges of soil degradation and environmental pollution by using modified machinery and restoring natural processes to reduce sugar-cane farming's impact on the environment and revive ailing crops and land. By returning organic matter to the land, replacing harmful chemical fertilizers with organic fertilization, and switching pesticides for a natural pest and disease management system, The Balbo Group has been able to enhance soil health, reduce environmental pollution, and increase their land's productivity by 20%. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The Balbo Group's approach incorporates several eco-innovation strategies. By developing a harvesting system called Ecosystem Revitalization Agriculture (ERA), The Balbo Group combines the principles of regenerative agriculture with technical innovation to replicate the resilient ecosystem of uncultivated land. By implementing an Integrated Organic Fertilisation Programme, The Balbo Group replaces potentially harmful fertilizers with organic waste products from the sugar mill. By using naturally resistant crop varieties, a biological control programme, and cultural control methods, The Balbo Group exchanges pesticides for a natural pest and disease management system. By valorizing all material flows and recycling organic by-products, The Balbo Group generates enough extra power to supply a city of 476,000 inhabitants. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular agriculture. Several critical success factors are evident in The Balbo Group case. The company's commitment to regenerative agriculture, its focus on waste valorization, and its dedication to

environmental stewardship have been essential to its success. The case also highlights the importance of addressing the root causes of soil degradation and environmental pollution and providing a sustainable and regenerative alternative. The agricultural implications of The Balbo Group's approach are also noteworthy. The company has been able to enhance soil health, reduce environmental pollution, increase their land's productivity, and generate enough extra power to supply a city of 476,000 inhabitants. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive agricultural outcomes, contributing to the overall sustainability and resilience of the food system.

Without Explicit Eco-Innovation

The Balbo Group grows organic sugar. They use modified machinery and restore natural processes to reduce sugar-cane farming's impact on the environment and revive ailing crops and land. The Balbo Group also produces 100% of the energy it needs to process around 6 million tonnes of sugarcane per year in thermoelectric power plants. The overall goal is to reduce sugar-cane farming's impact on the environment and revive ailing crops and land. The implementation of these practices has led to several positive outcomes. The Balbo Group has enhanced soil health, reduced environmental pollution, increased their land's productivity by 20%, and generates enough extra power to supply a city of 476,000 inhabitants. These results demonstrate the potential for innovative technologies and business models to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, The Balbo Group faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the regenerative agriculture practices, the potential for fluctuations in the supply of sugarcane, and the need for access to financing and investment. Additionally,

regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular agriculture model, The Balbo Group has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the sugarcane to the end-of-life management of the materials.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at The Balbo Group. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of sugarcane.
- Implementing closed-loop systems for the materials used in the sugar production process, where the materials are continuously recycled and reused.
- Expanding the use of renewable energy sources, such as solar and wind, to power the company's operations.
- Using sustainable materials in the packaging of the sugar, such as recycled or bio-based plastics.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, The Balbo Group can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable materials, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 31: São Paulo Municipal Government (Brazil)

“Regenerative agriculture around São Paulo: Connect the Dots”

The "Connect the Dots" program in São Paulo provides a compelling example of how to promote regenerative agriculture and create a circular economy for food, demonstrating the potential for integrating circular economy principles with social equity, environmental protection, and sustainable urban-rural linkages. This case highlights several key aspects relevant to the research objectives. First, "Connect the Dots" addresses the challenges of social inequality and unsustainable farming practices by supporting local farmers as they transition to regenerative practices and purchasing their produce to provide healthy food for vulnerable people. By paying farmers 30% more than the market value for their produce, providing technical assistance and training, and facilitating access to markets,

"Connect the Dots" incentivizes the adoption of regenerative practices, builds soil health, promotes biodiversity, and helps to tackle climate change. This showcases how circular economy principles can be applied to overcome these challenges and create positive social, economic, and environmental outcomes. The "Connect the Dots" approach incorporates several eco-innovation strategies. By supporting local farmers as they transition to regenerative practices, "Connect the Dots" promotes farming that works with nature and reduces reliance on synthetic fertilizers and pesticides. By creating a "farmer under agroecological transition" certification, "Connect the Dots" incentivizes farmers to adopt organic, regenerative practices. By developing a digital platform to support the management of technical assistance provided to farmers, "Connect the Dots" improves the efficiency and effectiveness of the program. By establishing a decentralized network of composting facilities, "Connect the Dots" returns organic waste to the soil and provides low-cost, high-quality compost to local farmers. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular food systems. Several critical success factors are evident in the "Connect the Dots" case. The program's commitment to social equity, its focus on regenerative agriculture, and its dedication to environmental protection have been essential to its success. The case also highlights the importance of addressing the root causes of social inequality and unsustainable farming practices and providing a sustainable and equitable alternative. The urban-rural development implications of "Connect the Dots" are also noteworthy. The program has been able to support local farmers, provide healthy food for vulnerable people, build soil health, promote biodiversity, and tackle climate change. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive urban-rural development outcomes, contributing to the overall sustainability and resilience of the food system.

Without Explicit Eco-Innovation

"Connect the Dots" aims to create a food system network that tackles social inequality and supports regenerative farming. The program supports and purchases produce from local farmers, to provide healthy food for vulnerable people. São Paulo municipality buys produce from these local farmers at 30% more than the market value to incentivize the transition to regenerative practices. The overall goal is to create a circular economy for food by supporting local farmers as they transition to regenerative practices. The implementation of these practices has led to several positive outcomes. "Connect the Dots" has supported local farmers, provided healthy food for vulnerable people, built soil health, promoted biodiversity, and tackled climate change. These results demonstrate the potential for government intervention to address social and environmental challenges.

Potential Challenges and Barriers: Despite the positive results, "Connect the Dots" faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the program, the potential for fluctuations in the supply of produce from local farmers, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the program's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular food system model, "Connect the Dots" has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the production of the food to the consumption and disposal of the waste.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at "Connect the Dots". These include:

- Promoting the adoption of sustainable production practices, such as agroforestry and conservation agriculture, to minimize environmental impact and enhance biodiversity.
- Implementing closed-loop systems for the materials used in the food production process, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the program's operations.
- Promoting sustainable consumption practices, such as reducing food waste and eating more plant-based foods.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, "Connect the Dots" can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the program's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable production, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.

- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

3.7 Case Studies in North America and Their Results

In North America, seven case studies, one from Canada, and six from USA are considered. Analysis of each case study in the context of without ecoinnovation and with eco-innovation integration is given below.

Case Study – 32: Circular economy procurement plan and framework: Toronto

“Circular economy procurement implementation plan and framework: Toronto”

The City of Toronto's Circular Economy Procurement Implementation Plan and Framework provides a compelling example of how municipalities can leverage their purchasing power to drive economic growth, enhance social prosperity, and move towards a zero-waste city. This case highlights several key aspects relevant to the research objectives. First, Toronto recognizes the significant potential of its annual purchasing contracts, valued at approximately CAD 2.7 billion, to influence suppliers and integrate circular economy principles into their business models. By outlining circular economy procurement objectives and identifying opportunities to leverage its buying power, Toronto aims to stimulate the market for circular products and services. This showcases how municipalities can use their procurement policies to promote circularity and achieve broader sustainability goals. Toronto's approach incorporates several eco-innovation strategies. By embedding circular criteria and options into procurement processes, such as

the Request for Quotations (RFQs) for food catering services, the city encourages waste reduction and supports circular food system outcomes. By encouraging circular design during the commissioning of street parklets, Toronto promotes the use of refurbished, reclaimed, reusable, and/or recyclable materials. By requiring suppliers of organic waste processing services to submit a Circular Economy Company Profile and create a Circular Economy Action Plan, Toronto incentivizes companies to invest in circular initiatives and report on their progress. By developing e-learning modules on circular procurement for City staff, Toronto builds capacity and promotes understanding of circular economy concepts. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular procurement practices. Several critical success factors are evident in the Toronto case. The city's commitment to zero waste and a circular economy, its cross-divisional collaboration, and its investment in staff training have been essential to its success. The case also highlights the importance of setting specific goals, managing risks, and communicating effectively with vendors. The economic and environmental implications of Toronto's approach are also noteworthy. The framework opens up new opportunities for businesses to win contracts, supports Toronto's wider goals of creating economic growth, enhances social prosperity, and moves towards zero waste in the city. This suggests that adopting a circular procurement framework can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the city.

Without Explicit Eco-Innovation

The City of Toronto's Circular Economy Procurement Implementation Plan and Framework has become a major tool to utilize municipal spending as a way to drive economic growth, enhance social prosperity, and move towards a zero waste city.

Toronto's annual purchasing contracts amount to approximately CAD 2.7 billion in value. The Framework outlines the City's circular economy procurement objectives in addition to a number of opportunities for the City to leverage its buying power. The overall goal is to drive waste diversion through the circular economy. The implementation of these practices has led to several positive outcomes. The framework opens up new opportunities for businesses to win contracts, supports Toronto's wider goals of creating economic growth, enhances social prosperity, and moves towards zero waste in the city. These results demonstrate the potential for government intervention to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Toronto faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the circular procurement framework, the potential for resistance from suppliers, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the city's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular procurement model, Toronto has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Toronto. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the city's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Toronto can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the city's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 33: City of Phoenix and Arizona State University collaboration

“Collaboration towards a circular economy: City of Phoenix and Arizona State University”

The collaboration between the City of Phoenix and Arizona State University (ASU) provides a compelling example of how city-university partnerships can accelerate the transition to a circular economy. This case highlights several key aspects relevant to the research objectives. First, the partnership demonstrates the value of bridging the gap between academic knowledge and real-world implementation. By leveraging ASU's research expertise and the City's operational capacity, the collaboration has been able to develop and implement innovative circular economy solutions. This showcases how city-university partnerships can drive innovation and accelerate the transition to a circular economy. The Phoenix-ASU collaboration incorporates several eco-innovation strategies. By establishing the Resource Innovation and Solutions Network (RISN), the partnership has created a platform for convening and connecting cross-sector stakeholders to eliminate barriers to implementing circular economy solutions. By conducting applied research studies and pilot projects, the partnership has identified and tested innovative solutions for waste diversion, greenhouse gas emissions reduction, and economic development. By launching the RISN incubator, the partnership has supported entrepreneurs in the early stages of circular economy innovation. By developing the Circular Living Lab (CLL), the partnership is redesigning recycling and remanufacturing value chains and empowering communities to convert plastic waste into economic opportunities and environmental benefits. This integrated approach aligns with the research's exploration of effective eco-

innovation strategies and circular economy initiatives. Several critical success factors are evident in the Phoenix-ASU case. The commitment of city leadership, the establishment of a formal partnership agreement, and the dedication of full-time project managers at both the City and ASU have been essential to its success. The case also highlights the importance of regular communication, data-driven decision-making, and collaboration across jurisdictional boundaries and borders. The economic and environmental implications of the Phoenix-ASU collaboration are also noteworthy. The partnership has more than doubled the city's waste diversion rates in six years, realized significant economic benefits, launched new businesses, created jobs, and increased revenues. This suggests that adopting a collaborative, eco-innovation-driven approach can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the city.

Without Explicit Eco-Innovation

Since 2011, the City of Phoenix and Arizona State University have partnered to accelerate the circular economy transition in the city. The partnership has played a critical role in more than doubling the city's waste diversion rates in six years. The collaboration aimed to bridge the gap between state-of-art academic knowledge and real-world implementation. The overall goal is to accelerate the circular economy transition in the city. The implementation of these practices has led to several positive outcomes. The partnership has more than doubled the city's waste diversion rates in six years, realized significant economic benefits, launched new businesses, created jobs, and increased revenues. These results demonstrate the potential for city-university partnerships to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Phoenix and ASU face several challenges and barriers. These include the need for ongoing maintenance and improvement of the circular economy initiatives, the potential for resistance from stakeholders, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the city's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, Phoenix and ASU have the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Phoenix and ASU. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the city's and university's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Phoenix and ASU can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the city's and university's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 34: Developing the materials marketplace: Austin

“Developing the materials marketplace: Austin”

The Austin Materials Marketplace provides a valuable case study on the development and implementation of an online platform to facilitate the exchange of waste and by-products between businesses and organizations. This case highlights several key aspects relevant to the research objectives. First, the Marketplace demonstrates the potential for creating a circular economy by diverting materials from landfill, reducing waste disposal costs, and creating additional income for businesses. By connecting businesses with surplus materials

to organizations that can reuse them, the Marketplace helps to close the loop and promote resource efficiency. This showcases how online platforms can be used to facilitate circular economy transactions and achieve broader sustainability goals. Austin's approach incorporates several eco-innovation strategies. By creating an online platform, the Marketplace makes it easier for businesses and organizations to find and exchange materials. By providing a reporting system, the Marketplace tracks the quantity and type of materials diverted from landfill and the associated environmental and economic benefits. By partnering with the US Business Council for Sustainable Development (USBCSD), the City of Austin leveraged the expertise of a non-profit organization with experience in materials exchange programs. By launching the [RE]Verse Pitch Competition, Austin supports local entrepreneurs in developing innovative reuse solutions. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the Austin case. The commitment of city leadership, the partnership with USBCSD, and the availability of funding for the initial investment phase were essential to its success. The case also highlights the importance of providing a user-friendly platform, tracking and reporting on performance, and connecting to wider waste prevention activities. The economic and environmental implications of the Austin Materials Marketplace are also noteworthy. Between 2014 and spring 2020, over 600 trades were facilitated via the Marketplace, diverting over 300 tonnes of material from landfill, and saving over 950 million tonnes of carbon dioxide equivalent emissions. This suggests that adopting a materials marketplace approach can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the city.

Without Explicit Eco-Innovation

The Austin Materials Marketplace is an online platform where businesses can exchange waste and by-products with organisations that can reuse them. As part of its ambition to reach zero waste by 2040, the City of Austin set up its Materials Marketplace, an exchange platform for businesses and organisations to trade surplus construction and demolition materials, plastics, organics, and packaging. The overall goal is to divert materials and products from landfill. The implementation of these practices has led to several positive outcomes. Between 2014 and spring 2020, over 600 trades were facilitated via the Marketplace, diverting over 300 tonnes of material from landfill, and saving over 950 million tonnes of carbon dioxide equivalent emissions. These results demonstrate the potential for online platforms to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, Austin faced several challenges and barriers. These include the need for ongoing maintenance and improvement of the materials marketplace, the potential for resistance from businesses and organizations, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the city's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, Austin has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Austin. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the city's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Austin can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the city's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 35: Artificial intelligence for recycling: AMP Robotics

“Artificial intelligence for recycling: AMP Robotics”

AMP Robotics provides a compelling example of how artificial intelligence (AI) can be used to improve the economics and efficiency of recycling. This case highlights several key aspects relevant to the research objectives. First, AMP's AI platform, AMP Neuron™, uses cameras to scan mixed waste streams and identify different materials, enabling more recyclables to be captured from waste streams and producing a greater volume of high-purity secondary resources. By classifying more than 100 different categories and characteristics of recyclables, AMP Neuron™ helps to overcome the challenges of identifying and sorting materials in a cost-effective manner. This showcases how AI can be used to enhance the efficiency and effectiveness of recycling processes and promote a circular economy. AMP's approach incorporates several eco-innovation strategies. By using AI and automation to improve waste sorting, AMP offers opportunities to improve performance and reduce operating costs, increasing the value of the secondary resources and improving the economics of recycling. By capturing data on volume and material composition trends, AMP's technology can be used to save time and lower costs across many areas of a materials recovery facility. By partnering with Waste Connections and Keurig Dr Pepper (KDP), AMP is scaling its AI-driven recycling solutions and expanding its reach into other areas of the circular economy. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the AMP Robotics case. The company's focus on developing a robust AI platform, its ability to classify a wide range of recyclable materials, and its partnerships with key players in the waste management and

consumer goods industries have been essential to its success. The case also highlights the importance of addressing the challenges of material recovery, meeting stricter international quality standards, and improving the economics of recycling. The economic and environmental implications of AMP's technology are also noteworthy. By increasing the volume of recycled material and improving the purity of secondary resources, AMP is helping to reduce the amount of waste sent to landfill and promote a circular economy. This suggests that adopting AI-driven recycling solutions can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the waste management system.

Without Explicit Eco-Innovation

AMP's artificial intelligence (AI) platform AMP Neuron™ uses cameras to scan mixed waste streams and identify the different materials. AMP Cortex™ is a high-speed intelligent robotics system that performs the physical task of sorting, picking and placing material based on information fed by the 'eyes and brain' of AMP Neuron. The overall goal is to allow more recyclables to be captured from waste streams, producing a greater volume of high-purity secondary resources. The implementation of these practices has led to several positive outcomes. In one recycling centre in Virginia that installed the technology, the volume of recycled material increased by 10%. These results demonstrate the potential for AI to address environmental and economic challenges.

Potential Challenges and Barriers: Despite the positive results, AMP Robotics faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the AI platform, the potential for resistance from workers, and the need

for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, AMP Robotics has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at AMP Robotics. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, AMP Robotics can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 36: Cradle to Cradle carpets for city buildings: San Francisco

“Cradle to Cradle carpets for city buildings: San Francisco”

The City of San Francisco's initiative to require Cradle to Cradle Certified carpets in city departments provides a compelling example of how policy can drive the adoption of circular economy principles in the built environment. This case highlights several key aspects relevant to the research objectives. First, the initiative demonstrates the potential for reducing waste and promoting material health by specifying carpets that meet strict environmental and health criteria. By requiring carpets to be at least Cradle to Cradle Certified Silver and free of certain chemicals of concern, San Francisco is reducing the amount of discarded carpets sent to landfill and ensuring the well-being of visitors and staff in city departments. This showcases how policy can be used to promote circularity and

achieve broader sustainability goals. San Francisco's approach incorporates several eco-innovation strategies. By focusing on the built environment supply chain, San Francisco was able to work towards meeting environmental and material health goals within city buildings and create new opportunities for suppliers to win city contracts. By requiring carpet tiles, the city promotes ease of replacement and avoidance of waste. By requiring minimum amounts of recycled materials in carpet fibers and backing materials, and ensuring that carpets are ultimately recyclable at end-of-use, the city promotes material recovery and reuse. By providing an online platform for city departments to find suppliers of compliant products, the city facilitates the adoption of circular economy practices. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the San Francisco case. The city's commitment to protecting citizens, safeguarding the environment, and preserving natural resources was essential to its success. The collaborative effort between various city departments, the Municipal Green Building Task Force, an external consultant, and city staff involved in public procurement was also crucial. The case also highlights the importance of engaging in robust research to understand product components, material transparency, and the potential of standards and certificates. The economic and environmental implications of the San Francisco initiative are also noteworthy. By creating new opportunities for suppliers and promoting material recycling and capture-for-reuse, the city is supporting its economic, environmental, and social goals. This suggests that adopting a policy-driven approach to circular procurement can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the city.

Without Explicit Eco-Innovation

In spring 2018, the City of San Francisco passed legislation that all carpets installed in city departments would be at least Cradle to Cradle Certified Silver and must not contain antimicrobials, fluorinated compounds, flame retardant chemicals, or other chemicals of concern. Similar requirements apply to carpet adhesives. Carpet tiles are to be used for ease of replacement and avoidance of waste. Additionally, both the carpet fibres and backing materials must contain minimum amounts of recycled materials, and ultimately be recyclable at end-of-use. The overall goal is to reduce the amount of discarded carpets sent to landfill and ensure the well-being of visitors and staff in San Francisco City departments. The support of the legislation by the City and County of San Francisco's elected mayoral leadership and Board of Supervisors also encourages the development of similar initiatives that support the city's economic, environmental and social goals.

Potential Challenges and Barriers: Despite the positive results, San Francisco faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the green carpet requirements, the potential for resistance from suppliers, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the city's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, San Francisco has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at San Francisco. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the city's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, San Francisco can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the city's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 37: The #WearNext campaign: New York City

“The #WearNext campaign: New York City”

The #WearNext campaign in New York City provides a compelling example of how a collaborative, multi-stakeholder initiative can promote circularity in the fashion industry. This case highlights several key aspects relevant to the research objectives. First, the campaign demonstrates the potential for reducing textile waste by encouraging New Yorkers to return clothes they no longer wear to collection points, keeping clothes in use and out of landfills. By uniting fashion brands, collectors, recyclers, and resale companies, the campaign created a platform for collaboration and knowledge sharing. This showcases how partnerships can be used to promote circularity and achieve broader sustainability goals. New York City's approach incorporates several eco-innovation strategies. By creating an interactive online map plotting the 1,100+ drop-off locations across the city, the campaign made it easier for New Yorkers to give their unwanted clothes a new life. By encouraging New Yorkers to repair, resell, or swap their old clothes instead of throwing them away, the campaign promoted a shift in consumer behavior. By commissioning campaign posters and leveraging social media, the campaign raised awareness of the huge quantities of clothing being sent to landfill and promoted solutions for keeping clothes in use. By partnering with retail brands to install textile collection bins in their stores, the campaign increased the availability of drop-off points. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the #WearNext campaign. The collaboration between DSNY, NYCEDC, and the Ellen MacArthur Foundation's Fashion programme was essential to its success. The participation of retail partners, textiles

collectors, resellers, and recyclers was also crucial. The case also highlights the importance of engaging in robust communications and outreach to raise awareness and promote behavior change. The economic and environmental implications of the #WearNext campaign are also noteworthy. By increasing the collection of unwanted clothing and diverting it from landfills, the campaign is helping to reduce the environmental impact of the fashion industry and save taxpayers money. This suggests that adopting a collaborative, multi-stakeholder approach to circular fashion can lead to positive economic and environmental outcomes, contributing to the overall sustainability and resilience of the city.

Without Explicit Eco-Innovation

Faced with the staggering statistic that New York City landfills receive approximately 100,000 tonnes of clothing each year – a quantity comparable to over 440 Statues of Liberty – a collaborative effort known as the #WearNext campaign was launched. This initiative united fashion brands, collectors, recyclers, and resale companies to encourage New Yorkers to recycle their unwanted clothing at designated collection sites across the city, thereby extending the lifespan of garments and reducing landfill waste. The central aim was to make textile recycling more accessible and convenient for city residents. The campaign's success was evident in the dramatic increase in engagement, with views of the DSNY's interactive map jumping almost 40 times (from around 3,000 to over 118,000). Moreover, clothing collections saw a significant boost, with 583 tonnes more collected compared to the same period the year before, translating to an average increase of 15%, and peaks of up to 48% in some areas. These results underscore the potential of collaborative campaigns to address pressing environmental and economic concerns

Potential Challenges and Barriers: Despite the positive results, New York City faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the #WearNext campaign, the potential for resistance from consumers, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the city's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, New York City has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at New York City. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the city's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, New York City can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the city's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

Case Study – 38: BlackRock embraces the circular economy

“The world’s largest investor embraces the circular economy: BlackRock”

BlackRock's engagement with the circular economy, particularly through the launch of its circular economy public equity fund, provides a significant example of how the financial sector can drive the transition to a more sustainable and regenerative economy. This case highlights several key aspects relevant to the research objectives. First, it demonstrates the growing recognition within the financial community that the circular economy is not only a way to address climate change and other global challenges but also a viable investment

strategy that can deliver long-term growth to investors. By launching a dedicated fund focused on companies contributing to or benefiting from the circular economy, BlackRock is signaling the financial sector's increasing interest in and commitment to this approach. This showcases how financial institutions can play a critical role in accelerating the adoption of circular economy principles across various industries. BlackRock's approach incorporates several eco-innovation strategies. By investing in companies like Adidas and Tomra, BlackRock is supporting businesses that are actively implementing circular economy practices, such as using recycled materials and providing infrastructure for recycling. By launching a public equity fund focused on the circular economy, BlackRock is creating a new investment vehicle that can attract capital to circular businesses and projects. By publicly advocating for the circular economy, BlackRock is raising awareness among other investors and companies and encouraging them to adopt similar strategies. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular economy initiatives. Several critical success factors are evident in the BlackRock case. The company's size and influence as the world's largest asset manager have given its engagement with the circular economy significant visibility and credibility. The strong leadership of CEO Larry Fink, who has publicly championed the circular economy, has also been crucial. The case also highlights the importance of demonstrating the financial viability of circular economy investments, as evidenced by the rapid growth of BlackRock's circular economy fund. The economic and environmental implications of BlackRock's engagement with the circular economy are also noteworthy. By directing capital to circular businesses and projects, BlackRock is helping to accelerate the transition to a more sustainable and regenerative economy. This suggests that the financial sector can play a key role in driving positive economic and environmental outcomes through circular economy investments.

Without Explicit Eco-Innovation

With a vast portfolio encompassing publicly traded equities, corporate and government bonds, and real assets, BlackRock stands as the world's largest asset manager. Recognizing the growing importance of sustainable business models, BlackRock launched a circular economy public equity fund in October 2019. The fund's investment strategy centers on identifying and supporting publicly listed companies that are actively driving or profiting from the transition to a circular economy. This initiative has served as a strong validation of the circular economy's potential, demonstrating its ability to generate attractive financial returns and enhance competitive positioning. As of July 2021, the fund had attracted over USD 2 billion in assets, reflecting the increasing market demand for circular economy investments.

Potential Challenges and Barriers: Despite the positive results, BlackRock faces several challenges and barriers. These include the need for ongoing maintenance and improvement of the circular economy fund, the potential for greenwashing, and the need for access to financing and investment. Additionally, regulatory hurdles and trade barriers could hinder the company's ability to expand its operations.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing circular economy model, BlackRock has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from the sourcing of the materials to the end-of-life management of the products.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at BlackRock. These include:

- Implementing sustainable sourcing practices to minimize environmental impact and ensure the long-term availability of resources.
- Implementing closed-loop systems for the materials used in the products, where the materials are continuously recycled and reused.
- Transitioning to renewable energy sources, such as solar and wind, to power the company's operations.
- Promoting sustainable consumption practices, such as reducing waste and buying more durable products.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, BlackRock can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- By implementing sustainable sourcing, closed-loop systems, and sustainable consumption, eco-innovation can improve resource efficiency and reduce reliance on virgin resources.
- By reducing greenhouse gas emissions and promoting the use of renewable energy sources, eco-innovation can contribute to climate change mitigation and help businesses adapt to changing climate conditions.
- By creating new business opportunities, generating local jobs, and promoting sustainable livelihoods, eco-innovation can contribute to inclusive economic development and improve the well-being of communities.

3.8 Case Studies in Oceania and Their Results

In Oceania, three case studies, one from New Zealand and two from Australia are considered. Analysis of each case study in the context of without eco-innovation and with eco-innovation integration is given below.

Case Study – 39: Orongo Cattle Station (New Zealand)

“Restoring a degraded landscape through design: Orongo Cattle Station”

The Orongo Cattle Station in Oceania provides a compelling example of restoring a degraded landscape through circular design principles, demonstrating the potential for integrating eco-innovation with environmental sustainability. This case highlights several key aspects relevant to the research objectives. First, Orongo addresses the challenge of land degradation, a significant barrier to sustainable agriculture. Through careful planning and design, the station has transformed previously unproductive land into a thriving ecosystem, showcasing how circular economy principles can be applied to overcome environmental challenges. The station's approach incorporates several eco-innovation strategies. By focusing on soil health, water management, and biodiversity, Orongo has created a system that mimics natural processes, reducing reliance on external inputs and minimizing waste. The integration of livestock grazing with ecological restoration demonstrates a service-oriented model, where the land provides a service (carbon sequestration, water filtration, biodiversity support) in addition to traditional agricultural outputs. This aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Orongo case. A long-term vision, a commitment to ecological principles, and a willingness to

experiment with innovative approaches have been essential to the station's success. The case also highlights the importance of understanding local environmental conditions and adapting strategies to specific contexts. This is particularly relevant to the research's focus on context-specific success factors in different regional contexts. The business implications of Orongo's approach are also noteworthy. While the primary focus is on ecological restoration, the station has also demonstrated the potential for economic benefits through increased productivity, reduced input costs, and enhanced brand reputation. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Orongo Cattle Station, located in Oceania, is an example of a land management approach focused on restoring degraded landscapes. The station has implemented practices aimed at improving soil health, water management, and biodiversity. These practices include holistic grazing management, keyline design, and the reintroduction of native plant species. The overall goal is to create a more resilient and productive ecosystem. The implementation of these practices has led to several positive outcomes. Soil health has improved, as evidenced by increased organic matter and water infiltration rates. Biodiversity has also increased, with the return of native plant and animal species. The station has also seen improvements in water quality and reduced soil erosion. These results demonstrate the potential for land management practices to restore degraded ecosystems and enhance environmental sustainability.

Potential Challenges and Barriers: Despite the positive results, Orongo faces several challenges and barriers. These include the initial investment costs associated with

implementing new land management practices, the need for ongoing monitoring and maintenance, and the potential for unforeseen environmental events (e.g., droughts, floods) to disrupt the restoration process. Additionally, changing market conditions and consumer preferences could impact the economic viability of the station.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing landscape restoration efforts, Orongo Cattle Station has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from input sourcing to waste management.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Orongo. These include:

- Implementing precision agriculture technologies, such as remote sensing and GPS-guided equipment, to optimize resource use (e.g., water, fertilizer) and minimize environmental impact.
- Transitioning to renewable energy sources, such as solar and wind power, to reduce reliance on fossil fuels and lower carbon emissions.
- Implementing waste valorization strategies to convert agricultural waste (e.g., manure, crop residues) into valuable products, such as compost, biogas, or biochar.
- Exploring opportunities to design and market circular products, such as sustainably raised beef or eco-tourism experiences, that minimize environmental impact and maximize value retention.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Orongo can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the station's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Precision agriculture technologies and waste valorization strategies can improve resource efficiency, reducing costs and minimizing environmental impact.
- Eco-innovation can enhance the provision of ecosystem services, such as carbon sequestration, water filtration, and biodiversity support, further contributing to environmental sustainability.
- By creating new products and markets, and by reducing costs through resource efficiency, eco-innovation can improve the station's economic performance and resilience.

Case Study – 40: Winona Farm (Australia)

“Profitable and resilient farming through grassland restoration”

Winona Farm in Australia provides a compelling example of profitable and resilient farming through grassland restoration, demonstrating the potential for integrating circular economy principles with sustainable agriculture. This case highlights several key aspects relevant to the research objectives. First, Winona Farm addresses the challenge of soil degradation and the need for more sustainable farming practices. Through the implementation of pasture cropping, the farm has transformed a conventional agricultural system into a regenerative one, showcasing how circular economy principles can be applied

to overcome environmental challenges and enhance productivity. The farm's approach incorporates several eco-innovation strategies. By combining livestock grazing and crop-growing in a complementary system, Winona Farm reduces reliance on external inputs such as herbicides and fertilizers. The pasture cropping cycle, where annual winter season cereal crops are direct-drilled into perennial pasture grasses, mimics natural processes and promotes soil health. The integration of livestock, whose dung and urine enrich the soil, further enhances the circularity of the system. This aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the Winona Farm case. The development of pasture cropping by Colin Seis and Darryl Cluff, their years of experimentation, and their commitment to regenerative agriculture have been essential to the farm's success. The case also highlights the importance of understanding local environmental conditions and adapting farming practices to specific contexts. The widespread adoption of pasture cropping by over two thousand farmers in Australia and other parts of the world further underscores its effectiveness and scalability. The business implications of Winona Farm's approach are also noteworthy. The farm has demonstrated increased profitability through increased weight gain in livestock, multiple revenue streams, and the avoidance of significant chemical inputs. This suggests that adopting an eco-innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

Winona Farm, located in Australia, is an example of a farming system focused on grassland restoration and sustainable agriculture. The farm has implemented pasture cropping, a technique that combines livestock grazing and crop-growing in a complementary system.

This involves direct-drilling annual winter season cereal crops into perennial pasture grasses, allowing the grains to grow out of the inactive grass. During the summer, the grasses flourish in the soil, which has been enriched by the livestock. The overall goal is to create a more resilient and productive farming system. The implementation of these practices has led to several positive outcomes. The farm has seen increased profitability, improved soil health, reduced soil erosion, and restoration of biodiversity-rich permanent grasslands. These results demonstrate the potential for sustainable farming practices to enhance environmental sustainability and economic performance.

Potential Challenges and Barriers: Despite the positive results, Winona Farm faces several challenges and barriers. These include the initial learning curve associated with implementing pasture cropping, the need for careful management of livestock and crops, and the potential for unforeseen environmental events to impact the farming system. Additionally, changing market conditions and consumer preferences could impact the economic viability of the farm.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing sustainable farming practices, Winona Farm has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire farming system, from input sourcing to waste management.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at Winona Farm. These include:

- Implementing precision livestock management technologies, such as GPS tracking and remote monitoring, to optimize grazing patterns and minimize environmental impact.
- Transitioning to renewable energy sources, such as solar and wind power, to reduce reliance on fossil fuels and lower carbon emissions.
- Implementing advanced monitoring techniques to accurately measure and verify carbon sequestration rates in the soil, allowing the farm to participate in carbon markets.
- Exploring opportunities to design and market circular products, such as sustainably raised meat or grain, that minimize environmental impact and maximize value retention.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, Winona Farm can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the farm's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Precision livestock management and renewable energy systems can improve resource efficiency, reducing costs and minimizing environmental impact.
- Eco-innovation can enhance the provision of ecosystem services, such as carbon sequestration, water filtration, and biodiversity support, further contributing to environmental sustainability.
- By creating new products and markets, and by reducing costs through resource efficiency, eco-innovation can improve the farm's economic performance and resilience.

Case Study – 41: BioPak (Australia)

“Closing the loop on single-use food packaging: BioPak”

BioPak in Australia provides a compelling example of closing the loop on single-use food packaging, demonstrating the potential for integrating circular economy principles with sustainable consumption. This case highlights several key aspects relevant to the research objectives. First, BioPak addresses the challenge of single-use plastic waste generated by the rapidly growing takeaway food sector. By offering compostable foodservice packaging made from renewable plant-based materials, BioPak provides an alternative to traditional plastic packaging, showcasing how circular economy principles can be applied to overcome environmental challenges associated with waste generation. The company's approach incorporates several eco-innovation strategies. By not only providing compostable packaging but also establishing a collection and composting service (Compost Connect), BioPak creates a circular system that ensures packaging and food waste are diverted from landfill and contribute to the preservation of healthy soils. This integrated approach aligns with the research's exploration of effective eco-innovation strategies and circular business models. Several critical success factors are evident in the BioPak case. The company's commitment to responsible sourcing of materials, its investment in composting infrastructure, and its collaboration with waste management partners have been essential to its success. The case also highlights the importance of consumer awareness and participation in closing the loop on single-use packaging. The business implications of BioPak's approach are also noteworthy. The company has demonstrated the potential for economic benefits through increased demand for sustainable packaging solutions and the creation of new markets for compost. This suggests that adopting an eco-

innovation-driven circular economy approach can lead to positive financial outcomes, contributing to the overall sustainability of the operation.

Without Explicit Eco-Innovation

BioPak, based in Australia, is an example of a company focused on providing sustainable alternatives to single-use food packaging. The company offers compostable foodservice packaging made from renewable plant-based materials. To ensure that its packaging is effectively composted, BioPak has established its own compost service, Compost Connect, which collects compostable packaging and food scraps from businesses and consumers. The overall goal is to divert organic waste from landfill and create nutrient-rich compost. The implementation of these practices has led to several positive outcomes. BioPak has diverted significant amounts of compostable packaging and food scraps from landfill, created valuable compost, and raised awareness about the environmental impact of single-use packaging. These results demonstrate the potential for sustainable packaging solutions to enhance environmental sustainability.

Potential Challenges and Barriers: Despite the positive results, BioPak faces several challenges and barriers. These include the limited availability of composting infrastructure in some areas, the need for consumer education and participation, and the potential for contamination of compostable packaging with non-compostable materials. Additionally, the cost of compostable packaging may be higher than traditional plastic packaging, which could limit its adoption.

Enhancing Sustainability Through Eco-Innovation Integration

Building upon its existing sustainable packaging solutions, BioPak has the potential to further enhance its environmental sustainability through the integration of eco-innovation principles. This would involve a more deliberate and strategic focus on reducing environmental impact across the entire value chain, from material sourcing to end-of-life management.

Scope for Eco-Innovation Integration: Several opportunities exist for integrating eco-innovation at BioPak. These include:

- Exploring opportunities to source feedstock from agricultural or industrial by-products, or from marginal areas that help restore degraded land.
- Redesigning packaging to minimize material use, improve compostability, and reduce the potential for contamination.
- Implementing digital technologies, such as QR codes or RFID tags, to track packaging throughout its lifecycle and ensure proper composting.
- Collaborating with governments, businesses, and communities to expand access to composting infrastructure and promote the adoption of compostable packaging.

How Environmental Sustainability Can Be Further Enhanced: By integrating these eco-innovation strategies, BioPak can further enhance its environmental sustainability in several ways:

- Eco-innovation can help to reduce the company's overall environmental footprint by minimizing resource consumption, waste generation, and pollution.
- Sustainable material sourcing and optimized packaging design can improve resource efficiency, reducing costs and minimizing environmental impact.

- By diverting organic waste from landfill and creating valuable compost, BioPak can contribute to improved soil health and reduced reliance on synthetic fertilizers.
- By demonstrating a commitment to eco-innovation, BioPak can enhance its brand reputation and attract environmentally conscious consumers.

CHAPTER IV

DISCUSSION AND RECOMMENDATIONS

4.1 Discussion on Enhanced Environmental Sustainability with Eco-Innovation Framework Integrated Circular Economy

Eco-innovation (EI) holds significant potential to facilitate the transition to a circular economy (CE) due to its multifaceted role (EIO, 2016). EI promotes circularity by integrating innovative processes, products, and services with evolving producer-consumer relationships and consumption patterns (Vence & Pereira, 2019). To achieve this, EI activities must be effectively integrated into a company's innovation strategies, processes, and environmental technologies (Sehnem et al., 2022). Consequently, monitoring EI activities is crucial for evaluating CE implementation at the company level and identifying policy implications (De Jesus et al., 2021). The pursuit of a CE is a key objective within the EU agenda, as highlighted by the Commission's New Circular Economy Action Plan, which emphasizes the importance of monitoring progress against climate and environmental challenges to integrate a stronger sustainability dimension and accelerate the transition to a CE (EC, 2020). To effectively link monitoring and assessing progress toward decoupling economic growth from natural resource depletion, further and improved measurement approaches are needed to account for resource use and its socio-economic impact on competitiveness and sustainability (EC, 2020). As highlighted by De Oliveira et al. (2021), most metrics used to assist decision-makers in evaluating circularity are environment-driven indicators that primarily focus on material and resource recovery. The authors argue that “a comprehensive assessment approach encompassing products, technologies, business models, and supply chains is necessary to support decision-makers in circularity assessments” (De Oliveira et al., 2021). Combining “circularity with

environmental, economic, and social sustainability performance assessments” (De Oliveira et al., 2021) is also essential for comparing the results of an organization reveals how the CE strategic decisions at the company level are taken and it is evident from my research observations in the case studies studied in chapter 3. A systematic literature review of methodologies for measuring the environmental impacts of circular systems within industrial and service sectors by Elia et al., (2017) reveals a lack of standardized methods for assessing the effectiveness of CE strategies, particularly at the company level. Roos Similarly, the literature analysis by Sassanelli et al., (2019) reveals a lack of methodologies for the overall evaluation of the CE benefits of circular systems. Despite the recognized importance of innovation in CE transition, prior studies highlight a limited understanding of EI dynamics within CE, particularly concerning strategy and policy implications (De Jesus et al., 2021; Kiefer et al., 2021; Konietzko et al., 2020). Through innovation efforts that enhance resource circularity, companies gain a competitive advantage while simultaneously achieving sustainability objectives that benefit company stakeholders and society as a whole (Rattalino, 2018). However, as Lieder and Rashid (2016) point out, benefits for the natural environment are easier to attain and understand than economic benefits. Effective company contributions to CE transitioning require an integrated approach to circular business models and innovative solutions for product and process design across the entire supply chain, ensuring company competitiveness through CE (Lacy & Rutqvist, 2015; Urbinati et al., 2017). As highlighted in the systematic literature review by De Jesus et al., (2021), metrics and assessment approaches for innovation toward CE are primarily qualitative and limited to the link between circular systems and financial performance, without considering all resources involved during the entire system lifecycle and affecting the environmental, economic, and social performance of innovation. A "multidimensional, multi-actor systemic innovation approach" appears necessary to

overcome the narrow focus on innovation in CE (De Jesus et al., 2021, p.14) and to implement a "circular economy studies" agenda as "applied and policy-relevant research that addresses the opportunities and challenges of sustained transition toward a CE through EI" (De Jesus et al., 2021, p.16). To account for the complexity of circular system innovation as a socio-technical transformation toward sustainable development, various studies adopt a Multi-Criteria Decision Making (MCDM) approach for measuring circularity (Alamerew et al., 2020; Eisenreich et al., 2021). Indeed, MCDM methods enable decision-makers to choose trade-off solutions that align with their preferences and evaluation criteria, which can be qualitative or quantitative (Dos Santos Gonçalves & Campos, 2022; Eisenreich et al., 2021). As widely recognized, addressing the intrinsic multidimensionality, complexity, and subjectivity of sustainability evaluations is among the strengths of MCDM methods (Liu & Ren, 2021; Merad et al., 2013). Accordingly, MCDM methods are used to support CE strategic decision-making regarding product design optimization and green supply chain management (GSCM) (Iakovou et al., 2009; Kazancoglu et al., 2018).

4.2 Discussion on Eco-Innovation Framework Integrated Circular Economy in Global South and Global North

Based on the case studies (identified shown in Appexdex A, and analysed ones in Chapter 3) and based on the policy documents search aimed at identifying circular economy (CE) initiatives in different countries, particularly the individual governing bodies within the UK and other European major players as stated in the European Commission CE action plan. Figure 4.1 illustrates the prevalence of CE initiatives in the Global North.

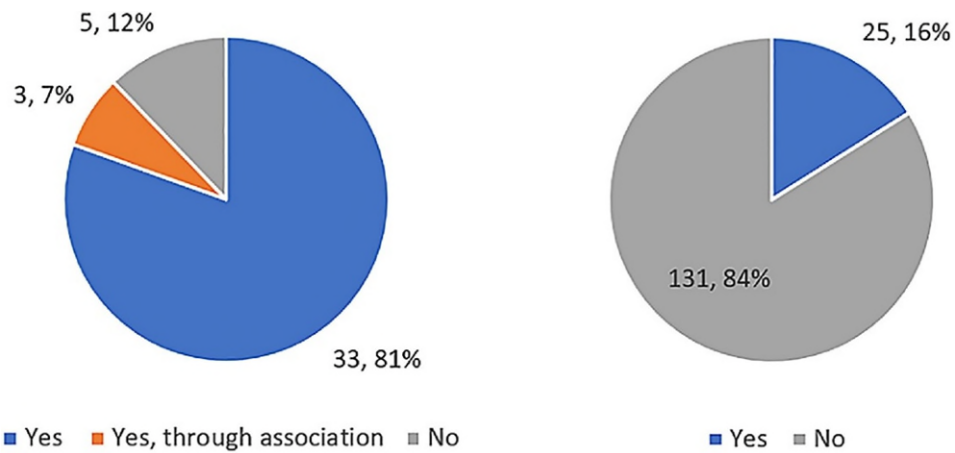


Figure 4.1. Prevalence of circular economy initiatives in the Global North over a Global South. Source: Adopted from Haswell et al., 2024

Figure 4.2 illustrates the geographical distribution of circular economy initiatives. With the exception of Azerbaijan, Belarus, Russia, and San Marino, all European nations have either implemented or are in the process of developing circular economy programs.

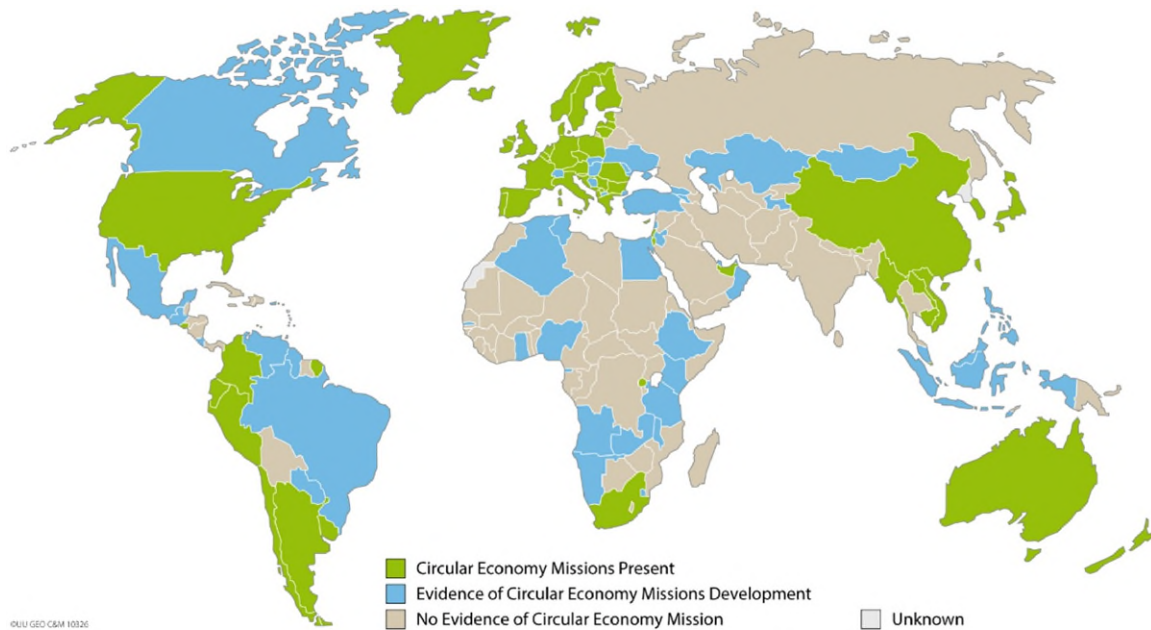


Figure 4.2. The geographical distribution of circular economy initiatives. Source: Adopted from Haswell et al., 2024

The imperative to transition towards sustainable economic models has spurred increasing interest in the “convergence of eco-innovation frameworks and the circular economy” (Amos et al., 2022). This discussion explores the distinct challenges and opportunities presented by this integration in the Global South and the Global North, highlighting the need for tailored approaches that consider regional contexts and developmental priorities (Sohanul, 2025). In the Global North, eco-innovation frameworks often focus on technological advancements, resource efficiency, and the development of new business models that promote circularity (Štreimikienė, 2026; www.datainsightsmarket.com). These frameworks are typically “driven by stringent environmental regulations, consumer demand for sustainable products, and the availability of financial resources for research and development” (www.rmit.edu.au). The integration of CE principles within these frameworks often involves strategies such as:

- “Investing in and deploying advanced recycling technologies to recover valuable materials from complex waste streams” (aracatinet.com).
- “Implementing eco-design principles to minimize environmental impact throughout the product lifecycle and promoting extended producer responsibility schemes” (Mollna et al., 2025).
- “Encouraging the adoption of circular business models such as product-as-a-service, leasing, and sharing platforms” (product.sustainability-directory.com).
- Developing supportive policies and regulations that incentivize CE practices and discourage linear consumption patterns.

However, the Global North also faces challenges in scaling up CE initiatives, including:

- Overcoming the inertia of existing linear infrastructure and supply chains.
- Shifting consumer preferences towards more sustainable consumption patterns.

- Addressing the complexities of global value chains and ensuring responsible sourcing of materials.

In contrast, the Global South presents a different set of challenges and opportunities for integrating eco-innovation and the CE. While access to advanced technologies and financial resources may be limited, the Global South often possesses a wealth of traditional knowledge, community-based initiatives, and a strong emphasis on resourcefulness. Eco-innovation frameworks in this context may prioritize:

- “Recognizing and supporting the role of the informal sector in waste management and resource recovery” (Schröder et al., 2019).
- Promoting community-led initiatives that address local environmental challenges and create economic opportunities.
- Developing and deploying appropriate technologies that are affordable, accessible, and adaptable to local conditions.
- Encouraging sustainable consumption patterns that are aligned with local cultural values and traditions.

Key challenges in the Global South include:

- Addressing poverty and inequality to ensure that CE initiatives benefit all members of society.
- “Overcoming the lack of adequate infrastructure for waste management, recycling, and resource recovery” (Borthakur and Singh, 2025).
- Strengthening governance and regulatory frameworks to promote environmental protection and sustainable development.

Moving forward, successful integration of eco-innovation frameworks and the “CE requires a nuanced understanding of the specific contexts and priorities of both the Global South and the Global North” (Lehtimäki et al., 2023). This includes fostering collaboration and knowledge sharing between regions, promoting technology transfer and capacity building, and developing innovative financing mechanisms that support CE initiatives in developing countries. By embracing a holistic and inclusive approach, we can “unlock the full potential of eco-innovation” (prism.sustainability-directory.com) and the “CE to drive sustainable development and create a more equitable and resilient future for all” (prism.sustainability-directory.com; Medupin et al., 2025; Lehtimäki et al., 2023).

4.3 Business Implications

The research underscores several key business implications for organizations seeking to integrate eco-innovation and circular economy principles (Table 4.1):

Table 4.1. Business Implications and the description showing how the organizations would need to pursue the eco-innovation with circular economy

Name of the implication	Description
Context-Specific Strategies are Crucial	A one-size-fits-all approach is ineffective. Organizations must tailor their CE strategies to the specific socio-economic conditions of their operating environment, particularly when navigating the differences between the Global South and the Global North.
Eco-Innovation as a Competitive Advantage	Integrating eco-innovation into CE strategies can drive competitive advantage by fostering resource

	efficiency, reducing costs, enhancing brand reputation, and opening access to new markets and customers.
Stakeholder Engagement is Essential	Successful CE implementation requires active engagement with a diverse range of stakeholders, including suppliers, customers, governments, and communities. Collaboration and knowledge sharing are critical for overcoming barriers and unlocking new opportunities.
Financial Performance and Value Creation	Adopting an integrated eco-innovation and CE approach can positively impact financial performance by generating new revenue streams, reducing waste management costs, and attracting investors seeking sustainable investments.
Policy and Regulatory Considerations	Organizations must be aware of and adapt to evolving policy and regulatory landscapes related to environmental protection and circular economy practices. Proactive engagement with policymakers can help shape supportive frameworks.

CHAPTER V

CONCLUSIONS AND THE WAY FORWARD

5.1 Summary of the Key Findings and Contributions

This thesis makes several key contributions to the understanding of eco-innovation and the circular economy. First and foremost is the Identification of Critical Barriers where The research identifies and categorizes the key barriers hindering effective CE implementation across diverse organizational and geographical contexts, providing a valuable framework for organizations to assess their own challenges. The thesis demonstrates how an eco-innovation framework can be strategically integrated with CE principles to overcome these barriers and drive enhanced environmental performance. It also explored the Context-Specific Strategies especially highlighting the importance of context-specific strategies, particularly when considering the distinct socio-economic conditions of the Global South versus the Global North. Lastly, the Business Implications and Value Creation when an integrated eco-innovation and CE approach is adopted is given, including impacts on financial performance, competitive advantage, and stakeholder engagement.

5.2 Limitations of the Study

While this thesis provides valuable insights, it is important to acknowledge its limitations:

- The multiple case study methodology, while providing rich contextual data, may limit the generalizability of the findings to all organizations and contexts.
- The availability and quality of data on CE initiatives and eco-innovation practices varied across different regions and industries, which may have influenced the scope and depth of the analysis.

- The thematic analysis of case study data involved a degree of subjectivity in coding and interpreting the findings, which may have introduced bias into the results.
- The case studies focused on specific sectors and industries, which may limit the applicability of the findings to other sectors.

5.3 Opportunities for Further Exploration

This thesis opens up several avenues for further research. First, the future works could employ quantitative methods to assess the impact of eco-innovation and CE practices on organizational performance and environmental outcomes. Second, adopting the longitudinal studies could track the long-term effects of CE initiatives and eco-innovation strategies on organizational sustainability and resilience. Third, having comparative analysis of CE implementation across different countries and regions could provide further insights into the role of policy, culture, and institutional factors. Also, the future research could focus on specific barriers to CE implementation, such as access to finance, technological limitations, or consumer behavior, and develop targeted strategies to overcome these challenges. Further research is needed to develop standardized metrics for measuring the circularity of innovative systems, considering the holistic nature of CE.

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APPENDIX A: SECONDARY DATA ON IDENTIFIED CASE STUDIES

Data Source: EllenMcArthur Foundation

Sr. No.	Country	City/State/Province	Case Study Title	Category(s)
1	China	Unknown	Redesigning the battery value chain: CATL-Brup	Critical Minerals
2	Denmark	Copenhagen	Enhancing climate resilience through nature-based solutions: Copenhagen	Unknown
3	Romania	Bucharest	Harnessing blue-infrastructure to meet the climate challenge: Văcărești Nature Park	Unknown
4	Switzerland	Unknown	Using material substitution to reduce and capture carbon: HAUT	Unknown
5	Germany	Unknown	Affordable living through modular construction: Gropypus	Unknown
6	Spain	Vitoria-Gasteiz	Regenerating nature — the foundation of a healthy, vibrant, and resilient city: Vitoria-Gasteiz	Unknown
7	France	Unknown	Breathing new life into vacant commercial buildings: Novaxia	Unknown
8	Unknown	Unknown	Collaborating to put nature first: The LENs	Unknown
9	Unknown	Unknown	3D printing in construction: Hyperion Robotics	Unknown
10	Italy	Unknown	Transforming fashion for a nature-positive impact: Gucci	Unknown
11	Netherlands	Unknown	Material-efficient prefabricated housing solutions: Daiwa House Modular Europe	Unknown
12	Unknown	Unknown	Brownfield revitalisation - an attractive opportunity for long-term investment: Ginkgo	Unknown
13	Germany	Hamburg	Public-private partnership unlocks nature-positive revitalisation: HafenCity	Unknown
14	Unknown	Unknown	Flexible and adaptable structures: CREE Buildings	Unknown
15	Slovenia	Ljubljana	Rethinking the city around nature: Ljubljana	Unknown
16	Sweden	Unknown	Prefabricated modular homes: BoKlok	Unknown
17	Netherlands	Amsterdam	Aiming for 100% circularity: Amsterdam	Unknown
18	UK	Glasgow	Activating food business networks: Circular Glasgow	Unknown
19	UK	London	Cross-cutting collaboration to transform the food system: London	Unknown
20	France	Unknown	France's Anti-waste and Circular Economy Law	Unknown
21	EU	Brussels	EU's Innovation Deal for a circular economy	Unknown
22	Denmark	Unknown	Circular Innovation City Challenge	Unknown
23	Unknown	Unknown	Cities collaborating with innovation ecosystems around digital, circular solutions	Unknown
24	UK	Glasgow	Driving a carbon-neutral city through mapping of resource streams & matchmaking	Unknown
25	Denmark	Copenhagen	Driving urban resources symbioses and radical circular innovation	Unknown
26	Unknown	Unknown	A climate-smart fertiliser that serves each farm's needs	Unknown
27	Unknown	Unknown	A leader in the circular built environment: Arup Group Limited	Unknown
28	Netherlands	Unknown	Why buy light bulbs when you can buy light? Signify	Unknown

29	EU	Brussels	The EU's Circular Economy Action Plan	Unknown
30	Netherlands	Brummen	A building that can be reused: Brummen Town Hall	Unknown
31	Germany	Munich	Dissolvable cleaning tablets: Everdrop	Unknown
32	UK	Unknown	Eliminating unnecessary plastic packaging: Tesco	Unknown
33	Sweden	Unknown	How H&M Group is progressing towards a circular economy in fashion	Unknown
34	Unknown	Unknown	Brewing beer from surplus bread	Unknown
35	Unknown	Unknown	Borrow stuff you need. Lend stuff you don't.	Unknown
36	Unknown	Unknown	Finding a fast fashion business model that lasts	Unknown
37	Wales	Unknown	A mobility revolution in Wales	Unknown
38	Unknown	Unknown	Seeking solutions to keep clothes in use: Tommy Hilfiger	Unknown
39	Unknown	Unknown	Clothing does not need to be physical to exist: The Fabricant	Unknown
40	UK	Unknown	The app making clothing alterations and repairs mainstream: SOJO	Unknown
41	Unknown	Unknown	Making circular business models more accessible: Lizée	Unknown
42	UK	Unknown	Clothing rental for users and retailers: Hirestreet	Unknown
43	Denmark	Unknown	Garments to be experienced by many, owned by none: GANNI	Unknown
44	Unknown	Unknown	Empowering luxury shoppers to choose better: FARFETCH	Unknown
45	Unknown	Unknown	Social peer-to-peer marketplace: Depop	Unknown
46	Unknown	Unknown	Empowering customers to care for their wardrobes: Clothes Doctor	Unknown
47	UK	Unknown	The social fashion rental app: By Rotation	Unknown
48	Lithuania	Unknown	Online market and community for fashion items and more: Vinted	Unknown
49	Portugal	Porto	Porto - Cities and the circular economy for food	Unknown
50	Singapore	Unknown	Cooling as a service: Kaer	Unknown
51	Sweden	Unknown	Creating trust in the sharing economy: Omocom	Unknown
52	Sweden	Unknown	An industry wide shared packaging system: Swedish Return System	Unknown
53	Italy	Unknown	The role of a bank in the circular economy: Intesa Sanpaolo	Unknown
54	Unknown	Unknown	Business-to-business asset sharing	Unknown
55	Unknown	Unknown	Watershed protection programme that builds value	Unknown
56	Italy	Unknown	Production of nylon yarn from waste materials	Unknown
57	Unknown	Unknown	Effective water systems for urban circularity	Unknown
58	Belgium	Flanders	Belgium: Flanders Materials Programme	Unknown
59	Netherlands	Unknown	Finding and utilising 'waste' materials for construction purposes	Unknown
60	Unknown	Unknown	Designing for a circular economy has more than one solution	Unknown
61	UK	Unknown	Collection, refurbishment and resale of mobile phone handsets	Unknown
62	Unknown	Unknown	How refurbishment can work	Unknown
63	Unknown	Unknown	Addressing barriers to support business innovation	Unknown
64	UK	Unknown	Bringing industry together to tackle food packaging waste	Unknown

65	Denmark	Unknown	Denmark: Public procurement as a circular economy enabler	Unknown
66	Unknown	Unknown	Reducing food waste, increasing profits: Winnow	Unknown
67	Netherlands	Unknown	Cradle to Cradle design of carpets	Unknown
68	Netherlands	Unknown	Pioneering circularity in the healthcare industry: Royal Philips	Unknown
69	France	Unknown	A peer-2-peer resale platform for fashion: Vestiaire Collective	Unknown
70	Italy	Milan	Collaborating to change local food systems: Milan	Unknown
71	Unknown	Unknown	Keeping the molecules and materials in use: Solvay	Unknown
72	UK	Unknown	An open access, circular supply chain for t-shirts: Teemill	Unknown
73	Unknown	Unknown	Improving the recovery and reuse of shipping steel	Unknown
74	Unknown	Unknown	Offering multiple benefits for multiple electronic products	Unknown
75	France	Unknown	Europe's first circular economy factory for vehicles: Renault	Unknown
76	Unknown	Unknown	Dissolvable stitches that improve clothing recycling: Resortecs	Unknown
77	Netherlands	Unknown	Redesigning medium-life bulky products from scratch: Niaga	Unknown
78	Netherlands	Unknown	Bringing office furniture full circle: Ahrend	Unknown
79	Belgium	Brussels	Regional programme for a circular economy: Brussels	Unknown
80	UK	London	Circular business support programme for SMEs in London	Unknown
81	Italy	Unknown	Effective Organic Collection Systems	Unknown
82	Netherlands	Venlo	City Hall from Cradle to Cradle: Venlo	Unknown
83	Unknown	Unknown	Sprite	Unknown
84	UK	Unknown	Fresh Handmade Cosmetics: Lush	Unknown
85	Italy	Unknown	Toxin-free, recyclable clothing: Napapijri Circular Series	Unknown
86	Netherlands	Unknown	Making new products from urban organic waste streams: De Clique	Unknown
87	Unknown	Unknown	Headphones as a service: Repeat	Unknown
88	China	Unknown	Reducing plastic waste in cosmetics through tech innovation: Yan An Tang	Plastics
89	Unknown	Unknown	Enhancing the quality of resale: Déjà Vu	Fashion
90	Unknown	Unknown	Saving office furniture from landfill: Deartree	Unknown
91	China	Unknown	China's policies to advance vehicle remanufacturing	Policy
92	China	Shanghai	Durable, 'timeless' products in small collections: klee klee	Fashion
93	China	Unknown	Enabling cashmere to be used for longer: ERDOS	Fashion
94	China	Unknown	Protecting resources by recycling precious metals: GEM	Design
95	Unknown	Unknown	Working with nature to make food last longer: Apeel	Food, Business
96	India	Andhra Pradesh	Andhra Pradesh Community-managed Natural Farming programme	Policy, Food
97	Japan	Unknown	Japan's disclosure and engagement guidance	Policy, Finance

98	Indonesia	Unknown	Farm-to-fork app eliminates plastic & reduces food costs: Kecipir	Food
99	India	Unknown	Greater resilience for smallholder farmers	Food, Climate
100	Ghana	Unknown	A regenerative supply chain alternative for palm oil	Food, Biodiversity, Climate
101	Unknown	Unknown	Insects as part of a circular economy for food	Food
102	Kenya	Unknown	Farm by-products increase yields and sequesters carbon	Food
103	Unknown	Unknown	Reducing food losses, increasing profits: Agricycle	Food
104	Africa	Unknown	Circular economy in Africa: examples and opportunities	Unknown
105	Unknown	Unknown	How to run a profitable circular farm: one-acre farm	Food, Biodiversity
106	South Africa	Cape Town	Matchmaking companies to turn waste into profit: Cape Town	Policy, Cities
107	New Zealand	Unknown	Restoring a degraded landscape through design	Biodiversity, Food, Climate
108	Unknown	Unknown	Profitable and resilient farming through grassland restoration	Food, Biodiversity, Climate
109	Unknown	Unknown	Closing the loop on single-use food packaging: BioPak	Design
110	Chile	Unknown	Chile's Circular Economy Roadmap	Policy, Climate
111	Unknown	Unknown	Pay for the product, not the packaging: Algramo	Plastics
112	Brazil	São Paulo	São Paulo - Cities and the circular economy for food	Cities, Food
113	Brazil	Unknown	Creating a regenerative economy in the Amazon Forest	Biodiversity, Business, Climate
114	Brazil	Unknown	Creating a reverse logistics ecosystem	Design
115	Brazil	Belo Horizonte	Tackling electronic waste in Brazil: Belo Horizonte	Cities, Policy
116	Brazil	Unknown	Regenerating an ecosystem to grow organic sugar: The Balbo Group	Food
117	Brazil	São Paulo	Regenerative agriculture around São Paulo: Connect the Dots	Food, Cities, Policy
118	USA	Phoenix, Arizona	Collaboration towards a circular economy: City of Phoenix and Arizona State University	Cities, Plastics, Policy
119	Canada	Toronto	Circular economy procurement plan and framework: Toronto	Cities, Policy
120	USA	Austin	Developing the materials marketplace: Austin	Cities, Policy, Climate
121	Unknown	Unknown	Reusing valuable resources more effectively: Rheaply	Business
122	Unknown	Unknown	How tool sharing could become a public utility	Business
123	Unknown	Unknown	Designing with existing materials: Looptworks	Fashion
124	Unknown	Unknown	A digital-only, multi-brand fashion platform: DRESSX	Fashion
125	Canada	Guelph	Guelph, Canada - Cities and the circular economy for food	Cities, Food
126	Unknown	Unknown	Regenerative ocean farming: GreenWave	Biodiversity, Food, Climate
127	Unknown	Unknown	A Second Life	Business
128	USA	Unknown	Finding rare earth elements above ground, not underground	Design
129	Unknown	Unknown	Closing the Nutrient Loop	Food

130	Unknown	Unknown	Artificial intelligence for recycling: AMP Robotics	Business, Plastics
131	Unknown	Unknown	Bringing printing as a service to the home	Design
132	Unknown	Unknown	The world's largest investor and the circular economy: BlackRock	Finance, Business
133	Unknown	Unknown	The online platform for scaling reuse: Trove	Fashion
134	Unknown	Unknown	Design and business model for heavy machinery remanufacturing	Business, Design
135	Unknown	Unknown	Packaging from 'mushroom plastic': Ecovative	Design
136	Unknown	Unknown	Keeping clothing in use to reduce waste: thredUP	Fashion
137	USA	New York City	The #WearNext campaign: New York City	Cities, Fashion, Design
138	USA	San Francisco	Cradle to Cradle carpets for city buildings: San Francisco	Cities, Policy
139	Unknown	Unknown	Alternative meat made from food by-products: Planetarians	Food
140	Unknown	Unknown	A smart refill system for household products: Replenish	Plastics
141	Unknown	Unknown	Working with nature to make food last longer: Apeel	Food, Business

**APPENDIX B: SECONDARY DATA ON IDENTIFIED BARRIERS AND
CHALLENGES FOR IMPLEMENTATING CIRCULAR ECONOMY**

Barrier Category	Challenges
Technological	1. Limited focus on end-of-life considerations during the initial stages of product design. 2. Scarcity of available recycled materials for production processes. 3. Lack of conclusive evidence regarding the consistent quality and performance of recycled Phase Change Materials (PCMs). 4. Insufficient practical experience with successful circular economy (CE) projects, coupled with a lack of established technical guidelines for product redesign, as linear technologies remain deeply entrenched. 5. Persistent inefficiencies that impede the development of innovative business strategies and a comprehensive sustainable footprint (e.g., eco-design, circular design, design for reuse, repair, refurbishment, remanufacturing, recycling, and design for service-based models). 6. Inadequate manufacturing capabilities to reliably produce high-quality remanufactured PCMs. 7. Potential operational risks stemming from the use of lower-cost or inferior technical solutions. 8. Absence of appropriate tools and data models to accurately assess the efficiency and effectiveness of CE projects, further complicated by thermodynamic constraints.
Financial	1. Significant initial investment costs associated with implementing CE initiatives. 2. The economic disadvantage of recycled materials often being more expensive than readily available virgin materials. 3. Restricted access to funding and financial support for circular economy business models. 4. Difficulties in accurately predicting and ensuring the consistent reliability of material return flows. 5. Hidden or unaccounted-for environmental costs associated with CE processes. 6. Dominance of a shareholder with short-term financial objectives that may conflict with long-term sustainability goals. 7. Increased management and planning expenses related to the implementation and oversight of CE projects. 8. Substantial capital tied up across various stakeholders within the CE value chain.
Infrastructural	1. Limited real-world application and scaling of innovative circular business models. 2. Lack of a secure and reliable information exchange system (IES) to facilitate data sharing and collaboration. 3. Inadequate capacity of reverse logistics networks to efficiently handle the exchange and return of materials. 4. Deficiencies in existing information management systems (IMS) to effectively track and manage CE-related data. 5. Shortage of qualified professionals with expertise in environmental management and circular economy principles. 6. Limited dissemination and sharing of innovative CE practices and knowledge. Entrenchment in existing infrastructure systems that are heavily reliant on resource-intensive linear processes. 7. A limited number of large-scale demonstration projects to showcase the viability and benefits of CE approaches.

	Insufficient access to technical resources, facilities, and equipment needed to support CE initiatives.
Institutional	- Lack of a globally recognized consensus on standards, definitions, and best practices for the circular economy. - Existing laws, regulations, and policies that may inadvertently hinder or obstruct the implementation of CE initiatives. - Absence of supportive policy frameworks specifically designed to promote and incentivize circular economy practices. - Lack of "smart" regulations that are flexible, adaptable, and tailored to the unique challenges and opportunities of the CE. - Limited adoption of circular procurement practices by government agencies and other large organizations. - A persistent gap in effectively integrating circularity principles into broader policy innovation efforts. - Financial governance structures and incentives that continue to favor traditional linear business models over circular alternatives. - Ineffective recycling policies that fail to ensure the creation of high-quality material flows for reuse and remanufacturing. - Unresolved governance issues related to responsibilities, liabilities, and ownership within circular economy systems. - Insufficient support and resources from public institutions to promote and facilitate the transition to a CE.
Societal	- An organizational culture that is resistant to change and hesitant to embrace circular economy principles. - Limited awareness of the potential benefits of CE and a lack of willingness among stakeholders to collaborate across the value chain. - A strong and ingrained attachment to the traditional linear "take-make-dispose" economic model. - Absence of visionary leadership to champion and drive the transition towards a circular economy. - Differences in attitudes, beliefs, and behaviors among employees regarding sustainability and circularity. - Constantly evolving consumer preferences and demands that can impact the viability of CE business models. - Limited awareness and understanding of circular economy principles among consumers. - A prevailing consumer preference for purchasing new products rather than refurbished, remanufactured, or recycled alternatives. - The dynamic and rapidly changing mindset of consumers, requiring businesses to adapt quickly to evolving expectations. - Restrictions on the types of customers that businesses are willing to serve with circular offerings. - Difficulties in securing cooperation and collaboration from external partners and suppliers. - Challenges in collaborating effectively with other companies due to partner restrictions or conflicting interests. - A general lack of willingness among some stakeholders to actively contribute to sustainability efforts. - A lack of trust and confidence among stakeholders, which hinders the open exchange of information and collaboration.