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Value co-creation within ecosystem: How value co-creation within industrial cluster could support a circular economy?

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ABSTRACT

This thesis examines how value co-creation within industrial clusters can enhance a circular economy, focusing on reusable cutleries. Utilizing a single case study approach across diverse sectors including forest industry, manufacturing, quick service restaurants, and logistics, the research identifies significant barriers to implementing circular economy principles, such as technological limitations, organizational resistance, and consumer hesitance. Key findings emphasize the importance of industrial symbiosis, suggesting that sustainability within clusters depends on effective resource sharing and collaboration among businesses. The study demonstrates that overcoming these barriers requires robust inter-organizational cooperation and integration, positioning value co-creation not merely as a business strategy but as an essential framework for advancing sustainable development. The conclusions provide both theoretical enhancements to the circular economy discourse and practical guidance for industry managers aiming to foster circular practices within their operations.

Tämä pro-gradu tutkii, kuinka arvon yhteisluominen teollisuusklustereissa voi edistää kiertotaloutta, keskittyen ruokailuvälineiden uudelleenkäyttöön. Käyttäen yksittäistä tapaustutkimusmenetelmää, tutkimus tunnistaa merkittäviä esteitä kiertotalouden periaatteiden toteuttamiselle, kuten teknologiset rajoitukset, organisaation vastustus ja kuluttajien epäröinti eri toimialoille, kuten metsäteollisuus, aterimien valmistus, pikaruokaravintolat ja logistiikka,. Keskeiset löydökset korostavat teollisen symbioosin merkitystä, ehdottaen, että kestävyys klustereissa on riippuvainen tehokkaasta resurssien jakamisesta ja yhteistyöstä yritysten välillä. Tutkimus osoittaa, että näiden esteiden voittaminen edellyttää vankkaa organisaatioiden välistä yhteistyötä ja integraatiota, sijoittaen arvon yhteisluomisen ei pelkästään liikestrategiaksi vaan olennaiseksi kehykseksi kestävän kehityksen edistämiselle. Johtopäätökset tarjoavat teoreettisia parannuksia kiertotalouden keskusteluun ja käytännön ohjeita teollisuuden johtajille, jotka pyrkivät edistämään kiertokäytäntöjä toiminnassaan.

KEYWORDS: circular economy, value co-creation, industrial symbiosis, reusable cutleries, industrial clusters, sustainable business models.

1. INTRODUCTION

1.1. Motivation for the study

This research paper builds on the existing body of literature that has studied the ongoing shift towards the circular economy (MacArthur, 2013; Geissdoerfer et al. 2017; Korhonen et al. 2018; Kirchherr et al. 2017). The existing literature has studied extensively how the concepts of circular economy and industrial ecology could be integrated into modern industrial systems and processes (Korhonen, 2000; Ayres & Ayres, 1996; Baldasarre et al. 2019; Frosch & Gallopoulos, 1989). The main contribution here is to gather insights from a very specific case study by including the ecosystem and value co-creation theories to understand the challenges of developing sustainable closed-loop systems. The case study is focused on the utilization of reusable cutleries in a closed loop system within quick service restaurant (QSR) sector and aims to find solutions for the barriers currently limiting the implementation. Furthermore, the key point of this research is to understand how reusable cutleries together with closed-loop systems could be implemented in a way that produces more value to the entire value chain. This is achieved by analyzing the individual stages of the product lifecycle and what type of collaboration or resource integration is required between the network actors. The broader context of this topic is driven by the current developmental trends and societal changes within the quick service restaurant (QSR) sector, and the interplay between various stakeholders to co-create value to promote the development of closed-loop systems.

That being said, the QSR sector is going through turmoil, as there is increased societal demand for sustainable solutions that minimize the environmental impact while allowing valuable raw materials to remain in a closed-loop system. This research will investigate reusable biocomposite cutlery manufactured from Finnish forest industry residues as a vehicle to understand the establishment of industrial clusters that follow the principles of circular economy and industrial ecology. In theory, the industrial cluster would support the use and circulation of reusable biocomposite cutlery by incentivizing cooperation through the increased business value each actor is receiving through the network. (Korhonen, 2000; Ayres & Ayres, 1996; Baldasarre et al. 2019; Frosch & Gallopoulos, 1989).

While the current literature has not established clear resources and mechanisms of collaboration to promote value co-creation within the research context, the results could be ambiguous and difficult to generalize due to the fundamental differences between industry sectors. The service dominant logic (SDL) can provide insights towards understanding the value co-creation process from the perspective of individual stakeholder. In other words, what are the resources and mechanisms of collaboration these stakeholders require and how to effectively deploy and integrate these as a part of the system (Nenonen & Storbacka, 2010; Lacoste, 2016).

1.2. Research gap

The existing literature has studied extensively the topic of sustainable development and circular economy which has also led to direct- or indirect branches of research in multiple streams of literature. When considering the feasibility of circular economy as a concept and the practical implementation to create value, it is necessary to take into consideration all the interconnected streams of literature.

The entire premise of circular economy is founded on the concept of emulating natural ecosystems' flow of energy and materials. This research area has been studied extensively within industrial ecology (IE) and industrial ecosystem streams of literature which also act as a predecessor for entire research on the circular economy concept. The research of industrial ecology (IE) and industrial ecosystems has built a foundation for understanding how the material- and energy flows within industrial systems could be adapted towards more sustainable practices at the industrial operative system level (Korhonen, 2000; Ayres & Ayres, 1996; Baldasarre et al. 2019; Frosch & Gallopoulos, 1989). However, it has also been acknowledged by Korhonen (2000) that the overarching issue with industrial ecology (IE) is the difficulty of constructing universal designs for industrial ecology management. This is because industrial ecology (IE) is closely linked with regional implementation and changing routine behavior and economic activity. Thus, for future research, it would be necessary to conduct very specific case studies on an industrial ecosystem or cluster to understand the possibilities for practical implementation of the concept.

The literature on circular economy (CE) has focused more specifically on the business model design of individual companies and how these can be adapted towards the principles of industrial ecology (IE) on the global scale (Geissdoerfer et al. 2017; MacArthur, 2013. This stream of literature has spawned concepts such as circular economy, sharing economy, and performance economy to implicate various forms of sustainable business models based on their core activities to drive economic growth (MacArthur, 2015). The focus of this research area has been to uncover how different sustainable business models could be integrated to the existing business ecosystem and there has not been clear solutions to this within existing literature. According to Geissdoerfer et al. (2017); "*the actual impacts of Circular Economy initiatives need to be analysed – how do these perform against the triple bottom line and contribute to 'strong sustainability' and slower forms of consumption, i.e., closing as well as slowing resource loops.".* Furthermore, Geissdoerfer et al. (2017) also argues that; *"it is critical to investigate the influence of a better understanding of the relationship between the Circular Economy and sustainability and their influences over the performance of supply chains, business models, and innovation systems".* However, the authors Kirchherr et al. (2017) have also added a new paradigm to this area of research by highlighting the importance of a consumer; "*more research on the consumer perspective could help to highlight pathways to enhance their contribution to CE".* In relation, Korhonen et al. (2018) has also raised important questions relating to the implementation and network of actors involved; *”Who is the leader in the network, who bears the biggest responsibility, who gains the most from the network operation, who loses the most if the project is unsuccessful or faces the biggest risks, what is the overall budget of the network, who controls it and which actors contribute to it, what is the network decision-making platform, who organizes it”.* This highlights that future research on the circular economy should take into consideration the overall impact on the economy and sustainability but also study the roles of different actors and how these are impacted (Korhonen et al. 2018).

The value co-creation research is closely interrelated to circular economy and industrial ecosystem research streams by focusing on understanding how different market actors interact and share resources to create more value through their processes. At the center of this research stream is the service-dominant logic (SDL) framework which suggests that customers or other network actors take active role in the value creation process. In other words, markets are considered as spaces where companies can deploy and integrate resources across different networks to co-create value together ((Nenonen & Storbacka, 2010; Arnould, 2008; Lusch and Vargo, 2006; Storbacka et al., 2008; Vargo, 2007; Vargo and Lusch, 2008b). The research of Saarijärvi (2012) has built on the previous research on value co-creation by focusing on the concept of value proposition and how the mechanics of value co-creation should support the overall value proposition of partnering network actors to incentivize cooperation. However, Nenonen & Storbacka (2010) argued that there is a gap within value creation literature as it does not explain the type of resources companies can have and what is the interface to co-create value. Thus, their research focused on the business model constructs to explain why certain network actors are more suitable towards mutual interaction in terms of value co-creation than others. Based on their research, Nenonen & Storbacka (2010) suggested that “*the current market configuration literature could benefit from the business model construct when depicting the structure and the evolution of market configurations.”.* In other words, the future research on the overall market configurations and business model combability could provide answers to the successful value co-creation and sustainable development. The research of Lacoste (2016) on the sustainable value co-creation process is an important framework that acts as a bridge between the other research areas by explaining the vertical relationship between different network actors throughout the entire product lifecycle. This research builds foundation for understanding the resources, interaction and level of communication needed by network of actors to implement sustainable products and services, and how their business models should be adjusted. However, the author does acknowledge that their research on sustainable value co-creation process has limitations due to the case selection and qualitative research method, which resulted in differentiating findings among case companies. Based on the findings, Lacoste (2016) suggested that future research on successful implementations of the framework could indicate; *"how companies build some intraorganizational learning from the sustainable value co-creation process that leads them to change their business model, deepening its service component".*

The literature gap relates to the practical implementation of industrial ecosystem and circular economy concepts within industrial clusters to develop closed-loop systems through the process of value co-creation and business model integration. The existing literature has developed a theoretical foundation for understanding development of market configurations and the role of business models in the process of sharing resources and capabilities among a network of actors. However, due to the ecosystem-, industry- and company-specific differences in resources, capabilities, and business environment affecting the value co-creation process, it is very difficult to have a universally applicable framework for developing industrial clusters. Thus, this research paper will aim to provide generalizable insights for the advancement of circular economy research but also fill the gap for understanding the value co-creation within QSR-sectors industrial cluster and the specific resources and mechanisms of collaboration needed together with the interface to co-create value as suggested by Nenonen & Storbacka (2010).

1.3. Research problem and theoretical contribution

This section will summarize how this research paper aims to fill the gap within the existing body of literature and contribute to the current theoretical- and managerial issues relating to the development of industrial clusters to advance the circular economy. This is achieved by going through the objectives of this research and presenting the research questions that are used to guide the direction of the research.

1.3.1. Research objectives

This research paper aims to fill the existing gap in the literature by building on the theoretical frameworks and introducing an industry-specific case study that will analyze the practical implementation of reusable biocomposite cutleries within the QSR sector. The SD-logic and sustainable value co-creation process frameworks are used to understand the key resources and mechanisms of collaboration needed throughout the product lifecycle to support the development, re-utilization, and recycling of reusable cutleries. Theoretically, this could provide practical input on how business models and company resources should be aligned within the industrial cluster to create a superior value proposition for the value chain as a whole. In essence, this research supports the widescale implementation of reusable products within a closed-loop system by defining the type of resources and mechanisms needed to promote development, re-utilization, and recycling across the value chain. The following research objectives have been defined to guide this process:

- Review existing literature on the value co-creation and cooperation within stakeholder networks or ecosystems.

- Establish key stakeholders who have a significant role in the value chain.

- Conduct detailed interviews on the utilization of reusable bio composite cutleries to learn about the benefits and constraints current infrastructure, service models, and consumer habits may create.

- Establish the level of interaction and sharing of resources- and capabilities required throughout the product lifecycle for effective implementation of the industrial cluster to co-create value.

- The findings of this research would hopefully contribute to the current literature by providing critical information on the link between mutual value co-creation across stakeholder networks and the advancement of circular economy.

- The practical implications of this research are to provide a pathway for society towards implementing reusable products and supporting a circular economy throughout the value chain.

1.3.2. Research question

The research paper draws on the notion that effective development, re-utilization, and recycling of reusable cutleries require collaboration, system integration, and knowledge sharing across stakeholder networks, Hence, answering the following research question:

What are the barriers and challenges of effective development, re-utilization, and recycling of reusable cutleries and resources and mechanisms needed to support this across industrial clusters?

1.3.3. Theoretical contribution

The theoretical contribution of this research paper is related to the advancement of industrial ecology- and circular economy concepts within industrial ecosystems and how the process of value co-creation supports this. More precisely, the contribution of this research paper will be on understanding the process of developing closed-loops systems through very specifically tailored case studies to analyze how different business models can be integrated to support value co-creation activities.

1.3.4. Managerial contribution

The managerial contribution of this research paper is to provide companies from both customer- and supplier networks with the strategic tools to implement inter-organizational interaction and coordination throughout the product lifecycle to co-create fully operational closed-loop systems. This allows companies to analyze their business models, build a better understanding of the market configuration of their ecosystem, and learn how different business models can be integrated to improve the value proposition for all parties involved.

1.4. Thesis structure

The research paper follows the standard structure of a thesis. At the beginning of the research paper, the motivation for the study and the identified research gap will be defined and presented. This is followed by the examination of research objectives and identification of research questions that guide the overarching body of work.

The literature review encompasses the key streams of existing academic literature in relation to the research questions to build theoretical framework for the empirical study. The core concepts to be studied include ecosystems, circular economy and value co-creation as these areas of research form the fundamental pillars for understanding sustainable closed loop systems.

The research methodology utilized is multiple case study that is adapted towards understanding different stages of an reusable product life cycle. The detailed approach towards case selection, data collection and data analysis will be discussed within the methodology section to elaborate on the context of this research paper.

The findings of the empirical study will be discussed and analyzed within the empirical findings section of this research paper. This is followed by conclusions of this research paper based on the existing academic literature and empirical findings, including the theoretical- and managerial implications as well as recommendations for future research.

2. LITERATURE REVIEW

This paper reviewed key literature on the concepts of circular economy, ecosystems, and value co-creation to build a theoretical foundation for understanding how industrial clusters could support the utilization of reusable cutleries and advance sustainability throughout the value chain.

2.1. Circular economy

The concept of circular economy is at the very center of this research as it guides the development of industrial economies and shifts towards sustainable business models. Therefore, it is crucial to establish the background and key concepts relating to this area of research, to build a foundation for better understanding the overarching theoretical frameworks of this research paper.

2.1.1. Development of industrial economy

This section will establish the different models of industrial economies that serve as fundamental pillars for linking the world economy and existing literature on sustainable development. When considering how an economy can affect sustainable development, Stahel (2016) proposed the utilization of systems thinking to map out the overarching interconnections and causalities between different business models. In other words, understanding how fundamental changes could save resources, and energy and improve employment.

Throughout history, our industrial economy has been built on the concept of linear economy, which has led to resource scarcity, pollution, and climate change on a global scale (Stahel, 2016). The fundamental idea of linear economy has been to meet market demand through the manufacturing of low-cost products from cheap virgin raw materials for high volumes. Furthermore, it has also been critical that the demand for new products is kept high to maintain constant economic growth. However, due to the limited natural resources available, this economic model is not sustainable given that the waste and raw material is not re-utilized in the production of new products.

Circular economy on the other hand is built on the concept of three R’s; reduce, reuse and recycle. Thus, the fundamental goal would be to lower excess consumption, attain maximal value from a product through multiple uses and keep the raw materials in circulation (Lahti et al. 2018). In theory, this would allow substantial savings in terms of energy- and resources, while also creating more jobs and preserving the global biodiversity and nature. Therefore, due to the lower overall consumption, businesses would have to shift from their traditional business models of build, use and dispose to creating economic value through the flow of materials and resources (Lahti et al. 2018).

Performance economy developed by Stahel (2016) is further changing the business model to be completely solution based service, where the ownership of a product or materials remains with the manufacturer, but consumers are able to realize the value through rent, lease and share business models. While the circular economy model is trying to minimize waste and improve the circulation of raw materials, it is still based on the exchange of ownership throughout the product lifecycle. In theory, society is ultimately able to achieve the greatest amount of environmental benefits through the reduced utilization of natural resources and energy by limiting change of ownership within individuals.

2.1.2. Background of circular economy

When considering the history of the circular economy, there is a handful of authors and practitioners who have contributed to the development and refinement of the circular economy concept since the late 1970s (MacArthur, 2013). These authors are responsible for developing the main schools of thought that have guided several branches of literature in the following centuries.

Regenerative Design by Lyle (1996) is based on the idea of society utilizing only the renewable resources available without causing environmental degradation. In other words, all the different systems within a society from agriculture onwards would be arranged to support regenerative consumption and renew the sources of energy and material consumed (Lyle, 996; MacArthur, 2013).

Stahel (2010) created the Performance Economy concept by researching how the economy could operate in loops and what effect this would have on the job creation, economic competitiveness, resource savings, and waste prevention (MacArthur, 2013). Stahel et al. (2010) also considered a product-life extension, long-life goods, reconditioning activities, waste prevention, and servitization of products as the cornerstones of the circular economy and framework for sustainable development. Thus, the concept of performance economy aims to minimize the concept of buying goods and move towards service-based models where resource utilization is maximized.

The Cradle to Cradle framework by Braungart and McDonough (2010) is built on the notion that all materials involved in industrial and commercial processes are considered as either technical or biological nutrients. In contrast to a performance economy, this framework does not promote the long-life extension of products as a way to support the circular economy but rather focuses on the flow of energy or raw materials in recycling streams and ease of recovery and reutilization within product design (MacArthur, 2013). Essentially, it

promotes the industrial flow of resources through effective design that maximizes the positive value of products.
A concept called Biomimicry was developed by Janine Benyus (1997) and the fundamental idea behind this discipline was to study the natural systems and models utilized by nature, and then emulate these to create innovative solutions for industrial problems. Thus, nature is characterized as a mentor which we can extract value from by learning about natural processes and it also provides an ecological standard to measure sustainability (MacArthur, 2013).

The Industrial Ecology concept has deep roots in the history of the Circular Economy, as it serves almost as an umbrella concept for different streams of literature through the idea of managing energy and material loops (MacArthur, 2013; Baldasarre et al. 2019, Frosch & Gallopoulos, 1989). Circular economy in general has developed almost into a supporting concept more distinguished with the operative functions as opposed to the long-term impact on the ecosystem (Baldasarre et al. 2019).

It can be concluded, that the modern conceptualization of circular economy has been influenced by several branches of literature and a lack of consensus since evidence suggests that there are several different definitions. Authors Kirchherr et al. (2017) analyzed 114 definitions from existing literature and found that 60% of researchers only focused on individual aspects of the circular economy such as recycling. In other words, many authors failed to consider circular economy from a system perspective and take into consideration the social, environmental, and economic perspectives as a whole.

The recent literature by Lahti et al. (2018) has defined circular economy as an environmental change in response to the global need for an ecological economy, requiring human activities that are aligned with three R´s principles: reduce, reuse, and recycle. In other words, the circular economy suggests that companies must replace their linear product life-cycle models with circular models that are based on reused, recycled, or repaired materials. Based on the report of the MacArthur (2013), the different circular operative models can be summarized as follows:

Reuse of goods: The products are used multiple times with little to no modifications to their original form to reduce the overall environmental impact by slowing down the material loops. This model has its roots in the performance economy developed by Stahel (2010).

Product refurbishment: is a process of restoring or repairing a product into a working condition by replacing or repairing the most essential components. This can also cover possible visual changes for products to make them updated, thus also slowing down the material loops as the product will be utilized for longer periods as opposed to buying a new model of the same product.

Component remanufacturing: a process of dismantling a non-functioning product into spare parts that can be then utilized for the manufacturing process of new products. This process provides a reduction in the utilization of virgin raw materials.

Cascading of components and materials: can be considered as the recycling of different materials either through mechanical or chemical recycling into new products or raw materials, and for example, composting of organic materials to be utilized as fertilizer or energy source.

In essence, the purpose of the circular economy model is to maximize raw material usage while minimizing the environmental impact throughout the lifecycle. Based on this, the fundamental value proposition would have to shift towards making profits through the flow of resources, materials, and products over time. Consequently, companies can reduce the negative environmental impact they have on the environment.

However, according to Corvellec et al. (2022), there are several critiques of the circular economy concept who believe that it has diffused limits, unclear theoretical grounds, and the practical implementation has many structural challenges throughout the ecosystem. In other words, the critics of circular economy believe that the concept is based on an ideological agenda with no real contribution towards sustainability and fails to provide theoretical and practical value for sustainable growth.

Lahti et al. (2018) also acknowledged the fact that this type of grand transformation within the socio-economic environment requires industrial network actors to closely collaborate and coordinate between mutual processes to achieve closed- or slow-material loops. Therefore, Lahti et al. (2018) proposed a circular business model to explain how firm uses innovation to deliver- and capture value through the implementation of circular economy principles, where the business rationale is realigned with the network of stakeholders to meet environmental, social, and economic benefits.

2.1.3. Relationship between circular economy and sustainability

When considering the circular economy it is also necessary to discuss the relationship it holds with the concept of sustainability. In essence, sustainability can be thought of as the overarching objective of mitigating and solving environmental problems such as biodiversity loss, pollution, resource depletion, and excessive land use, which are jeopardizing earth's life-support systems (Geissdoerfer et al. 2017). Furthermore, social sustainability is an equally important aspect as it accounts for issues such as unemployment, poor working conditions, social vulnerability, poverty traps, inequalities, supply chain risks, and deregulated markets, which cause economic instability for individual people, companies, and economies (Geissdoerfer et al. 2017). A large number of authors, governments, political parties, and companies have given their support for the circular economy as the solution to such sustainability issues. Circular business models have been in many cases deemed undeniably necessary for the development of sustainable manufacturing and economic growth, although societal changes in lifestyle and consumption patterns are also needed (Rashid et al. 2013; MacArthur, 2013; Bakker, 2014; Nakajima, 2000; United Nations Environment Program, 2006; European Commission, 2014).

However, even with a number of authors and political parties supporting the circular economy as the most appropriate approach to deliver the highest environmental, economic, and social benefits, there is still an unclear conceptual relationship (Geissdoerfer et al. 2017). Authors Andersen (2007) and Allwood (2014) share similar views on the possible negative drawbacks of circular economy, which could have a detrimental impact on overarching sustainable development. In other words, Andersen (2007) and Allwood (2014) proposed that the technical feasibility of building circular infrastructure and the energy demand could have negative value over traditional business models. Thus, they suggest that adapting to the circular economy principles could in turn accelerate global warming and increase the amount of greenhouse gasses if adequate research has not been conducted.

It is also pointed out by several scholars such as Bocken et al. (2014), Allwood et al. (2012), Garetti and Taisch (2012), and Seliger (2007), that circular economy is only a single sustainable business model among many others. This highlights that there are perceived benefits for different sustainable business models and combining these could lead to further gains and synergies in terms of promoting sustainable development at economic, environmental, and social levels. In other words, further research should be conducted on the combined benefits of different sustainable business models to develop a holistic approach to solving global sustainability issues.

2.1.4. The shift from linear economy towards circular economy

When considering the past century when the economy has thrived by linear consumption patterns, industries have accustomed to the utilization of low-cost fossil-based energy sources and resources (MacArthur, 2013). This has supported strong economic growth within developed countries, while policymakers and industry leaders have failed to take into consideration the long-term effect of wasteful resource usage (MacArthur, 2013). Therefore, the global economy has utilized an immense amount of resources to manufacture products that are designed to be disposed as waste at the end of life when there is no further value for the consumer. According to MacArthur (2013), the recycling rates for most materials are far below the actual manufacturing rates, which supports the notion that a significant portion of our valuable resources are not utilized to the full extent. In relation, approximately 65 billion tons of raw material was used to manufacture goods in 2010 and this number grew to around 80 billion tons in 2020. For example, the EU alone generated 2,7 billion tons of waste in 2010 and only 40% of this was reused, recycled, or composted (MacArthur, 2013). The current research confirms that only a fraction of waste material is being reused, recycled, or composted when analyzing individual waste streams (MacArthur, 2013).

However, while the resource loss through linear consumption patterns has been a major driver of change towards the circular economy, some researchers have also highlighted the potential economic benefits. For example, it is estimated that the EU manufacturing sector alone could benefit up to 600 billion euros in annual economic gains and the global economy up to 1000 billion dollars by operating under circular economy principles. (European Commission, 2015; Korhonen et al. 2017; MacArthur, 2013; FICF, SITRA & Mckinsey, 2014). This has given national governments a significant economic incentive to support a wide-scale shift towards the circular economy. In turn, circular economy has become the recommended approach towards economic growth through aligning with sustainable environmental and economic development (Korhonen et al. 2015).

While China began implementing circular economy policies already in 2008, recent findings in research have led several national governments to demand change by promoting circular economy principles across industries (Korhonen et al. 2018). Both the European Union (EU) and the Chinese government have introduced laws to stimulate the transition toward a Circular economy. For example, the European Parliament approved a circular economy package in 2018, which included a range of policies an actions to start reducing waste across Europe. These measures included targets for the recycling of materials such as plastic, wood, ferrous metals, aluminum, glass, paper, and cardboard (Lahti et al. 2018). The latest laws to support a shift towards a circular economy within the EU include the Single-Use Plastic Directive (SUP) and the Packaging- and Packaging Waste Directive, which ban certain products and set clear guidelines for future development by promoting the use of reusable products and packaging (European Commission, 2022). The increasing number of legislative measures introduced by governments is certainly a key component for the future development of sustainable business models as it could enforce a higher level of collaboration across stakeholder networks.

2.1.5. Barriers to the circular economy

Although many governments, companies, practitioners, and researchers support the shift toward circular economy-based business models, it has been established by both critics and supporters that there are fundamental barriers to the circular economy. In essence, this section will discuss the potential barriers to a circular economy from the perspective of governments, organizations, suppliers, society, consumers, technology, and economic principles.

Governmental and legislative barriers

The governmental perspective can be considered one of the most notable barriers to the advancement of circular economy models, as the existing research and literature have already proven the importance of ecosystem-wide collaboration where governments have very high influence (Lahti et al. 2018). In other words, governments hold a key role by enforcing laws and legislations that support the shift towards the circular economy, while also providing economic- and financial incentives for companies. Furthermore, supporting programs that foster innovation in a local setting act as a foundation and catalyst for the development of eco-efficient strategies (Corvellec et al. 2022).

The global world economy has been steered by cost efficiency and infrastructure to support linear consumption models, thus the shift towards a circular economy could potentially require high upfront investments and induce higher raw material costs (MacArthur, 2013; Corvellec et al. 2022). Therefore, a lack of government intervention through laws, legislation, and financial support could cause unwillingness among companies, industries, and even consumers to participate in circular business models (Corvellec et al. 2022).

However, as it has been established, there is increasing support for a circular economy from the European Union. The European Commission (2022) will be presenting rules, guidelines, and restrictions, which ultimately enforce sustainable sourcing, manufacturing, and consumption patterns within member countries. For example, the European Union will be advocating the use of reusable alternatives to replace a significant amount of single-use items in the European market through legislation (European Commission, 2022). This will effectively enforce new more sustainable consumption patterns by removing unsustainable alternatives from the market.

Organizational barriers

When considering customers, supporting organizations, and suppliers, certain key barriers hinder the effectiveness of circular economy business models. For example, Corvellec et al. (2022) argue that technological capabilities to innovate and produce circular products can be considered as a challenge due to the interconnected nature of the circular economy concept on an ecosystem level. Consequently, The operations, facilities, and infrastructure to enable the collection, reuse, recycling, and refurbishment of products as a part of the value chain have to be aligned with the collective needs of the entire ecosystem. This only highlights the importance of resource integration and mechanics for mutual value co-creation. (Corvellec et al. 2022).

According to Korhonen et al. (2018) and Baldasarre et al. (2019), the inter-organizational management of industrial networks has a key role in ensuring the value co-creation to enable collection, reuse, recycling, and refurbishment of products as a part of the value chain. However, inter-organizational sustainability management can be considered very challenging, when there are several independently operating entities collaborating across the ecosystem to advance circular economy principles. In other words, how each of these companies and local or regional public authorities distribute risks, responsibilities, and decision-making between the network without creating a conflict (Korhonen et al. 2018).

The research of Korhonen et al. (2018) highlights important aspects of the inter-organizational sustainability management systems, which may also support the conclusion, that governments hold a key role in leading and enforcing ecosystem-wide collaboration. The current quality-, safety- and environmental standardization systems, which also serve as a business requirement in a commercial setting, might create a conflict of interest when these are not aligned with circular business models. For example, ISO 14001 Environmental Management Standard is focused on the reduction of waste material flows within a single company, but in a circular business model or industrial cluster increasing these material flows could be beneficial if used as raw material or energy sources for other companies within the network (Korhonen et al. 2018). Therefore, the potential environmental impact and sustainable contribution may have to be considered from the perspective of the entire ecosystem while mutually agreed standards and processes would have to be established (Korhonen et al. 2018).

Society and consumer barriers

When considering the shift towards the circular economy, it is also necessary to estimate how society and consumers perceive a fundamental change in their consumption patterns. That is to say, even if all the technology and infrastructure needed to support the new circular business models were readily available, it would be redundant if consumers and society did not accept the new consumption patterns these innovations would entail (Corvellec et al. 2022). For example, the utilization of reusable biocomposite cutleries within the Finnish ecosystem requires a fundamental shift away from single-use culture, while adding more responsibility to the consumer to support proper collection and sorting systems for the cutleries. In addition, fast food restaurants might be reluctant to organize the collection and washing of reusable items if there are increased costs and operational complexity involved.

The research of Corvellec et al. (2022) has shown that the understanding of the circular economy concept is very limited in the general population, and the ability to improve public participation can also be difficult. Furthermore, the public conception of circular economy and their willingness to participate in the utilization of refurbished or reusable products is also shown to be low in different studies (Corvellec et al. 2022). Consumers are used to buying 150 items that fulfill 85% of their needs and alleviating this consumption habit can be associated with a higher level of risk, personal responsibility, and poor customer experience, thus lowering their level of interest in participating (Kirchherr et al. 2018; Hawkins et al. 2012; Borra et al. 2014; Kumar and Polonsky 2017; Schneider and Hall, 2011).

Therefore, to successfully implement circular economy strategies within the society it is essential to raise awareness and establish laws and legislations that enforce the desired consumption patterns. That being said, the current actions from the European Commission (2022) such as the Single-Use Plastic directive (SUP) and the Packaging- and Packaging Waste Directive (PPV) have received significant public awareness due to the radical changes presented and could be considered as a step towards the right direction in the light of existing literature.

Technology barriers

Based on the existing literature there are differentiating opinions on the relevance of technology barriers for the circular economy transition, even though it is generally agreed as an important prerequisite. 35% of the earlier research ranging from 2012 to 2018 has raised technology barriers as the biggest challenge for transitioning towards a circular economy (Kirchherr et al. 2018). It is argued that the technological prerequisites for advancing circular economy have not been met and that the ability to seize opportunities from circular economy principles is still limited or hindered by technological bottle necks (Preston (2012; Shahbazi et al. 2016).

However, Kirchherr et al. (2018) argue that their latest research has shown opposite results as several interviewees have stated that the technology barriers belong to the least pressing challenges in the transition towards the circular economy. This contrasting information could be linked to the societal- and organizational issues addressed by Corvellec et al. (2022), which might implicate that variables such as costs, operational changes, and cultural hesitance might also influence the decision-making policies. In other words, technological limitations could be used as a way to steer the conversation away from new operative models that potentially disrupt current practices. The conflicting results of current research on technological barriers only highlight the need for further research. Furthermore, due to the relevance of this topic, the overarching findings of this research paper could potentially shed more light on the existing technology barriers to the circular economy or how these could be alleviated in the future through value co-creation.

Economic barriers

When considering the economic barriers to the circular economy, Kirchherr et al. (2018) argued these might be the most critical for global implementation of circular products and services. The research of Kirchherr et al. (2018) suggests that the number of different barriers can be related to the causality of a chain reaction, and due to the overarching impact an economy can have, this causes a ripple effect.

The low market prices for virgin raw materials have been a common issue within the global world economy, as the current linear business models have been incentivized to utilize fossil-based plastics (MacArthur, 2013; Kirchherr et al. 2018). In addition, the high upfront investment costs for the utilization of new innovative materials or technologies further increase the risks companies would have to accept. In other words, companies would not be price competitive, and tremendous trust would be placed in the change of society and consumer habits. Kirchherr et al. (2018) argued that these types of barriers are at the very center of influencing hesitant company culture, and consumer habits, and society may never evolve if new innovative models are not proposed or developed.

However, the markets and ecosystems are operated by companies and infrastructure with established resources, operative models, and processes. Thus, when considering a new innovative model such as reusable cutleries made from biocomposite, it will disrupt the existing market configuration and processes (Korhonen et al. 2018, Corvellec et al. 2022).

In other words, the adaptation of this innovation would require inducing change within the existing market environment, which may fail to penetrate the market based on path dependency theory (Korhonen et al. 2018).

In essence, the economic barriers can have a significant impact on the success or failure of the circular business models due to the overarching effect it holds for the different subsequent areas of the market environment. However, as stated, governments and countries can legally enforce change, which only highlights the fundamental importance of government-led funding, taxation, and legislation proposals to foster innovations within the global economy (Lahti et al. 2018, Corvellec et al. 2022).

Implications

Based on the existing literature, there is ample evidence demonstrating that technological barriers do not have a significant impact on the successful circular economy transition as many industry experts have completely dismissed this proposition (Kirchherr et al. 2018). In contrast, it has been shown that a lack of consumer interest and awareness as well as a hesitant company culture are the main barriers to a circular economy (Corvellec et al. 2022, Kirchherr et al. 2018). According to Kirchherr et al. (2018), this phenomenon is driven by the prevailing market environment, which provides incentives for businesses to follow linear business models and disincentivize circular business models, due to the lower costs and risks associated. Thus, consumers are also directed to follow linear consumption patterns as the mainstream alternative. Consequently, the overarching barriers to circular economy transition can be considered as a ripple effect from inadequate governmental intervention and support (Kirchherr et al. 2018).

Therefore, it can be argued that the successful transition towards a circular economy requires significant involvement and support by the government, which is acknowledged by researchers such as Lahti et al. (2018) and Kirchherr et al. (2018). In essence, the current literature suggests that the route towards breaking cultural barriers should be paved by government actions towards banning or de-incentivizing unsustainable business models and materials, while also providing financial support for green innovations (Kirchherr et al. 2018). When considering the latest announcement relating to the packaging- and packaging waste directive (PPW) and single-use plastic directive (SUP), the governmental actions are aligned with the research. These directives have banned certain plastic items from the market and set ambitious goals for increasing the recycling rates and amount of reusable items to support sustainable development (EU Commission, 2022). Whether these actions can lower the established cultural barriers is a topic for further research in the coming years.

2.2. Ecosystem

This section focuses on reviewing the existing literature on the ecosystem concept to build a better understanding of the market environment and how a network of actors operates to support the overarching discussion of this research paper.

2.2.1. Background

The fundamental concept of ecosystems can be initially traced back to nature's ecosystem and how earth can sustain itself through material- and energy flows (Korhonen, 2000, 2001). However, the increasing awareness of the unsustainable nature of modern society and industrial development has spawned new streams of literature to understand this phenomenon and how it could be applied to industrial systems. Industrial ecosystem is a concept where industrial systems try to mimic nature's ecosystem by creating a recycling system for material- and energy flows through cooperation and industrial ecology (IE) studies the interaction between industrial- and nature systems (Korhonen, 2000, 2001; Frosch and Gallopoulos, 1989; Ayres & Ayres, 1996).

2.2.2. Natural ecosystem

The natural ecosystem represents the fundamental flow of materials and energy within nature, which allows life to be sustained within the earth. According to Korhonen (2000, 2001), the flow of materials within the natural ecosystem is cyclical and flows through three stakeholders; plants as producers, animals as consumers, and bacteria, decomposers, or fungi as recyclers. These entities utilize each other's waste materials as input materials for construction as well as energy sources. In essence, the only external input to the entire ecosystem is infinite solar energy, which plants bind into chemical form to be consumed and recycled, while eventually the energy is released back into space as waste heat (Korhonen, 2000).

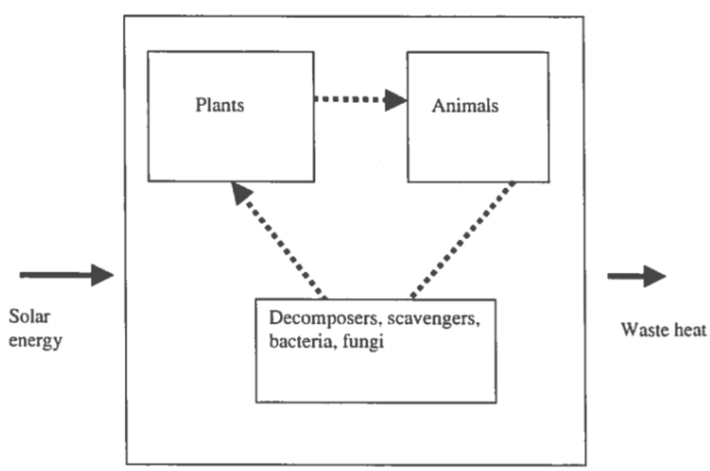

Figure 1. Simplified flow of matter in an natural ecosystem (Korhonen, 2000).

2.2.3. Industrial Ecology

The concept of Industrial Ecology (IE) spawned at the beginning of the 1990s when concerns about the environmental impact of industrial activities started to rise, which used raw materials as an input to develop products and waste to be disposed of (Baldasarre et al. 2019, Frosch & Gallopoulos, 1989). Thus, Industrial Ecology served as a response to create a better understanding of the interaction between industrial and natural ecosystems. In other words, it reflects on the process of material and energy flows within nature as depicted in [Figure 1] and how similar processes could be implemented in an industrial system (Korhonen, 2000, 2001).

Authors Ayres & Ayres (1996) had a key role in the development of the modern IE concept through their reflection on it as a recycling system for industries operating similarly to nature. Since then, the IE concept has evolved up to a point where it is considered the “science of sustainability”, which takes into account the entire ecosystem ranging from raw material sourcing to production processes, service delivery, and social well-being. In essence, IE studies the material and energy flows within the ecosystem and between the industrial operators. The concept has acted as lenses to understand how biological material cycles of nature could be adapted to construct a strategy for sustainable development of industrial activity and processes (Korhonen, 2000, 2001).

Based on the research of Baldasarre et al. (2019), Industrial Ecology (IE) could also be practically applied in the implementation and evaluation of eco-industrial clusters through industrial symbiosis. In other words, a network of manufacturing and service businesses could develop their environmental and economic performance by improving collaboration and resource management. The overarching goal would be to build a closed loop system where waste is eliminated through the minimization of virgin raw material inputs and recycling of material outputs. Therefore, in this model waste would be used as feedstock within the industrial cluster that operates similarly to nature, thus reducing the overall environmental impact of the activity (Baldasarre et al. 2019, Ellen MacArthur, 2013; Ehrenfeld & Gertler, 1997; Erkman, 1997; Graedel et al., 2015; Massard et al., 2014).

2.2.4. Business ecosystem

As a separate entity from traditional ecosystem discussion, which is based on sustainability, business ecosystems provide insight into the collaboration of organizations from value creation and operative perspective. According to Lappi et al. (2015), the business ecosystem concept is strongly based on the notion of different independent actors operating in a system where their relationships and goals are intertwined. In other words, organizations that operate in an ecosystem are all directly or indirectly participating in the value co-creation process. Therefore, they are also impacted by the value co-creation and the achievement of system-level goals. Despite the fact, that relationships between these organizations can have either a negative or positive impact on the system-wide goals, the ecosystem concept proposes that participation between organizations yields higher value creation. This is significantly affected by the fact that each organization operating within the ecosystem might have different perceptions and goals. Thus, if the incentives and goals of different organizations within the ecosystem are not aligned, they will not be successful in the long term (Lappi et al. 2015).

Based on the research of Lappi et al. (2015) it could be argued that reaching global environmental objectives through the development of industrial ecosystems that operate similarly to nature can be difficult to implement. In other words, the goals and objectives of different actors within an ecosystem could easily be misaligned due to the individual organizations' needs relating to their operational capabilities, funding for investments, business strategy, and economic profitability.

However, referring to the research of Baldasarre et al. (2019) and Korhonen (2000, 2001), building on the concept of Industrial Ecology through the development of Industrial ecosystems or clusters within a local setting can build a foundation for new business growth and improved profitability. This is achieved through the reduction of virgin materials- and energy while also maximizing the monetary value of outputs (products, energy, and waste). That being said, it should be noted that the development of an industrial ecosystem or cluster is highly dependent on the organizational network's ability to find mutual alignment for value co-creation and resource management in both environmental and economic terms.

2.2.5. Industrial ecosystem

The concept of industrial ecosystem is derived from the industrial ecology (IE) literature and it describes a local collection of industrial actors that utilize each other's waste material and residual energy through cooperation, thus replicating nature´s recycling system (Korhonen, 2000, 2001; Frosch and Gallopoulos, 1989; Ayres & Ayres, 1996). The basic principle of the industrial ecosystem is to substitute raw materials and energy that the industry sources from nature with waste, thus reducing the total virgin material input and waste or emission outputs from the system (Korhonen, 2000, 2001). While this provides clear environmental benefits, it is also economically feasible to consider the utilization of waste as a resource and cascading of energy throughout the ecosystem, since this allows a reduction in raw material, energy, and waste management costs (Korhonen, 2000, 2001).

When considering an idealized vision of an industrial ecosystem, the local companies within an industrial cluster would engage in cooperation to emulate the organism of nature as depicted in Figure 1. (Korhonen, 2000, 2001). In essence, following the industrial ecosystem analogy indicates that all resources within the local system ranging from raw materials to energy would be recycled to meet the highest level of efficiency. In other words, the waste output by some actors within the system can be used either as a raw material for new products, nutrition, or feedstock for agriculture or it can be used to generate green energy through biogas or district heating for example. In the most optimal setting these material- and energy flows could be circulated indefinitely throughout the system, which would essentially run on waste and green energy supplied through the local system (Korhonen, 2000, 2001).

Therefore, the economic – and environmental benefits from an industrial ecosystem are immense as the utilization of local waste as a resource to produce new products and recycling of waste and green energy across system processes allow significant reductions in costs, wastes and emissions (Korhonen, 2000, 2001). In this constantly changing market environment this can be presented as a substantial competitive advantage within global arenas where sustainability, traceability and transparency of raw material origin and price competitiveness are critical for customers. The industrial systems utilizing solely green energy and generating outputs from side streams or residues within the industrial system could also receive potential taxation or legislative benefits in the future. That is to say, EU Commission (2022) is discussing potential government legislations and green taxes over the utilization of fossil fuels or raw materials that are not aligned with global environmental objectives to stop the climate change. Hence, it can be argued that the concept of industrial ecosystems have a key role in the future research in academia, but also in the development of sustainable business models to counter climate change.

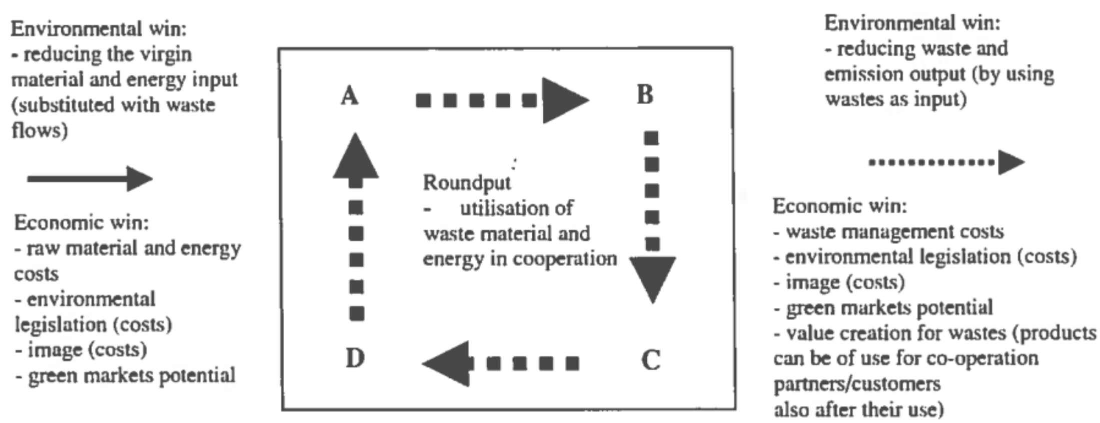

Figure 2. Basic industrial ecosystem model (Korhonen, 2000).

Industrial symbiosis

When considering the shift from a linear towards a circular economy, Industrial symbiosis (IS) is an important umbrella concept, providing further understanding of the role of value co-creation as a key driver to support cooperative networks. According to Baldasarre et al. (2019) and Korhonen (2000, 2001), different industries could create a competitive advantage through cooperative networks that allow the exchange of materials, energy, water, and by-products. Furthermore, this type of cooperation could provide an opportunity to address issues such as resource depletion, waste management, and pollution, which are at the very center of sustainable development. The research of Baldasarre et al. (2019) aims to have a better understanding of the practical development of industrial clusters by studying two conceptual perspectives; Industrial Ecology (IE) and Circular Economy (CE). Based on this, the CE -perspective builds knowledge on the practical functionality and operative design of the cluster from a business point of view, while the IE -perspective provides a better understanding of the overarching impact the cluster could have on the environment, economy, and society as a whole.

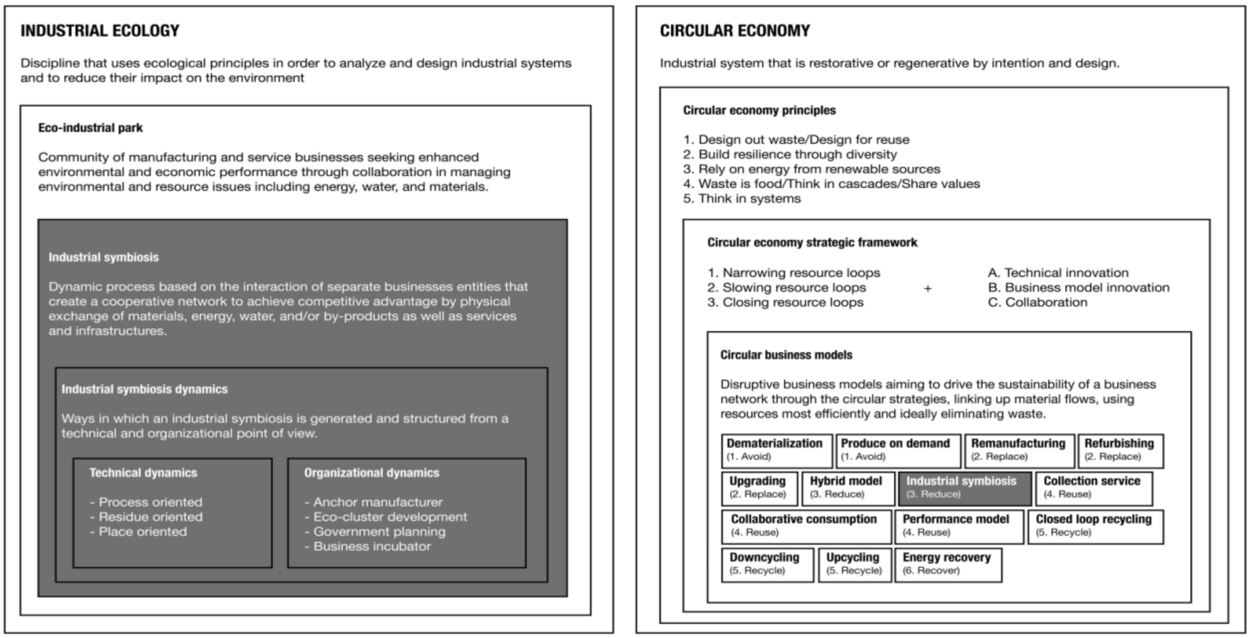

Figure 3. Locating industrial symbiosis in the industrial ecology and in the circular economy research streams (Baldasarre et al. 2019).

Industrial symbiosis as a socio-technical process

Based on the research of Baldasarre et al. (2019), industrial symbiosis (IS) can be framed as a socio-technical process from an industrial ecology (IE) perspective or a business model archetype from a circular economy (CE) perspective. The main difference is that IE analyzes the ecosystem-level events, while CE focuses on the development of a functional business model (CE). The IE perspective is based on the cooperation of separate business entities within the industrial cluster to exchange materials, energy, by-products, services, and infrastructure to achieve competitive advantage and optimize material- and energy flows to reduce the environmental impact of their processes (Boons et al., 2014, 2011; Chertow, 2007; Massard et al., 2014). From the CE perspective, the business model is designed to improve resource efficiency across the value chain by utilizing waste as a source of value creation. The business model is based on a technical innovation that allows different participants of the industrial cluster to exchange materials, energy, or services to reduce the economic- and environmental cost of their operations. In essence, both perspectives have synergies by focusing on the same issues but through different lenses based on the way the issue is framed.

From the industrial ecology (IE) perspective, the IS process (Figure 4.) can be divided into three subsequent phases, which consist of starting conditions, events, and outcomes as outlined by Baldasarre et al. (2019). The antecedents for establishing an IS cluster within the first phase of the process can be considered as an overview of organizational involvement and definition of the relationships, technical systems, and overarching motivation for collaboration. The second phase depicts the technical-, social- and policy actions that are implemented within the industrial cluster to support the overall needs and objectives. For example, the directives by the EU Commission (2022) to guide both social- and technical development within the packaging industry can be considered as such action. The final phase of the IS process summarizes the overall impact a cluster has on the economic-, social- and environmental levels and evaluates the feasibility (Baldasarre et al. 2019).

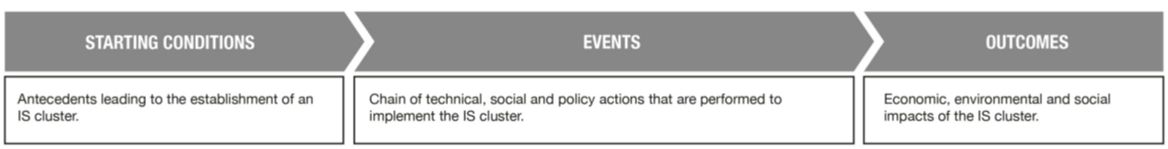

Figure 4. Industrial Symbiosis framed as a socio-technical process. Based on: (Boons et al., 2017, 2014, 2011; Chertow, 2007; Massard et al., 2014; Sun et al., 2017)

From a circular economy (CE) perspective, the three phases of the IS process (Figure 5.) were described as technical innovation, collaboration, and sustainable business model innovation by Baldasarre et al. (2019). The first phase of technical innovation can be defined as a process that allows waste, energy, and resources to be shared across industrial processes to create more value. The second phase, collaboration, can be considered as the establishment of a stakeholder network necessary for the development and operation of a circular business model. The final phase of sustainable business model innovation can be summarized as the overarching value proposition obtained from the contribution of technical innovation and industrial collaboration (Baldasarre et al. 2019).

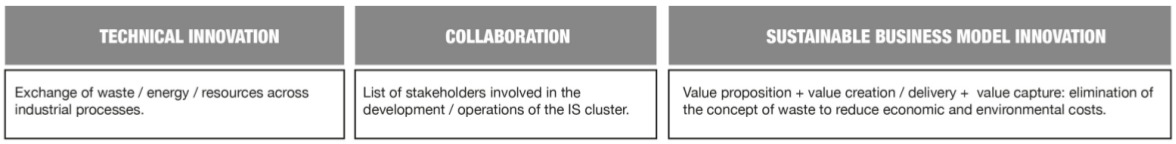

Figure 5. Industrial symbiosis framed as a circular business model. Based on: (Albino & Fraccascia, 2015; Bocken et al., 2014; Fraccascia et al., 2016; Kraaijenhagen et al., 2016; Short et al., 2014)

When considering the IS process as a whole, it is indeed both a socio-technical process and a business model archetype since both concepts are necessary for the overall implementation of such a complex model. In other words, it is essential to understand the overarching impact that an industrial cluster can have to reflect on the benefits and drawbacks it holds on the environment as a whole. However, it is also necessary to have a functional business plan or operative model to implement this type of process in practice. That is to say, the IE and CE perspectives create synergies that allow the entire picture to be viewed through the correct lenses and enable long-term sustainable development. The IE perspective tries to provide answers to the question of what is required to be done, and the CE perspective provides answers to the question of how this is achieved in practice through business model integration.

Practical implementation of the IS process

To discuss the practical application of the IS process framework on the development and implementation of reusable biocomposite cutleries within industrial clusters both IE and CE perspectives should be used as lenses for understanding the paradigm. These are necessary for defining the overarching process of creating an industrial cluster that is completely self-sustainable and requires no fossil fuels or virgin raw materials to produce reusable biocomposite cutleries.

The first phase of the IS process can be linked to the establishment of partnerships between the forest industry, product manufacturers, the HoReCa sector, and end processors to support the circular economy. In clarification, the forest industry has developed an innovative biocomposite -material from side stream waste of their existing processes, which acts as an antecedent for ecosystem-wide collaboration. This material can be used to manufacture reusable cutleries with the latest hi-tech injection molding technology. The reusable biocomposite cutleries enhance the customer experience within the HoReCa sector while also fulfilling the sustainability objectives more effectively and meeting the requirements of EU legislation and directives (EU Commission, 2022). The end processors or forest industry would then ideally organize the recycling of the raw material back to compounding where it will return to circulation as new products. The second phase of the IS process can be considered as the actual implementation of the IS cluster, which entails the technical development of recycling infrastructure, the establishment of a stakeholder network for operative design, and a social shift towards reusable alternatives enforced by governmental policies and legislation. Finally, the value proposition and overall outcome of the IS cluster can be assessed through the reduction of virgin raw material usage, lowered CO2 footprint, and economic growth through the development of new jobs to support reusability and infrastructure to enable recycling.

All in all, the IS process framework can theoretically be used to develop a sustainable system for the HoReCa sector, which would be based on sourcing raw materials from side streams of local forest industry processes to manufacture sustainable and reusable products by PPW and SUP-directive (EU Commission, 2022). The utilization of the IS process framework allows the entire network of companies within the cluster to map out the critical partners and processes needed to support efficient material- and energy flows and streamline their operational efficiency and self-sustainability. Therefore, the findings of this research paper can have a pivotal role in guiding the development of industrial clusters focused specifically on the efficient development, re-utilization, and recycling of reusable biocomposite cutleries. Thus, supporting the disruptive shift from disposables to reusable alternatives within the HoReCa sector.

2.3. Value co-creation

This section will focus on discussing the theoretical frameworks of value co-creation to build a bridge between circular economy and industrial clusters by establishing mechanisms for collaboration and resource management.

2.3.1. Background

Value creation as a concept dates back to the 1980s and is closely related to marketing research to understand how value can be created for customers (Lacoste, 2016). The value creation research stream was originally based on the goods-dominant logic (GDL) where suppliers had an active role in the value creation process by embedding value into the goods manufactured through enhancing their attributes (Lacoste, 2016; Vargo et al., 2008). However, as the business environment evolved, the research streams for value creation also shifted to understand the complexity of modern businesses. This has led to the spawn of service-dominant logic (SDL), service system, and viable system approach (VSA) concepts, which shifted the focus towards value co-creation by assuming that suppliers, customers, and independent systems take an active role in the value creation process (Lacoste, 2016; Nenonen & Storbacka, 2010; Edvardsson et al., 2011; Kohtamaki et al., 2016).

According to Nenonen & Storbacka (2010), the fundamental shift from a linear goods-dominated economy towards a knowledge-intensive, collaborative, and resource-integrative value network paradigm has acted as a catalyst for service-dominant logic (SDL) research. The early SDL research streams have mainly focused on the customer-driven process where suppliers and customers co-create value through cooperative interaction and customer experiences (Kohtamaki et al., 2016; Lacoste, 2016; Prahalad, 2004). However, it is also argued that services are the fundamental basis of exchange and all economic- and social actors are resource integrators that interact across system boundaries within the market to co-create value (Lacoste, 2016; Vargo and Lusch, 2004). This has led to a more refined view of the SDL research, where markets are considered as spaces where companies can deploy and integrate resources across different networks to co-create value together. In other words, the concept of value co-creation has spread from a supplier-customer-driven process to address the entire global economy (Nenonen & Storbacka, 2010; Arnould, 2008; Lusch and Vargo, 2006; Storbacka et al., 2008; Vargo, 2007; Vargo and Lusch, 2008b).

The viable system approach (VSA) is a theory that considers each entity or business within the ecosystem as a separate system that has its own micro environment (Barile et al. 2012; Polese et al. 2017). Furthermore, it suggests that each of these systems is immersed within a network of systems throughout the ecosystem and looks for viable companies and actors to interact with (Nenonen & Storbacka, 2010). Based on the VSA research, Polese et al. (2017) have also suggested that the roles and dimensions of S-D logic could surpass the customer as the sole participant to extend into various parties in the service exchange or value creation process. In other words, various actors within an ecosystem could have an active and crucial role in the value-creation process through direct or indirect participation in a networked system of economic actors (Kohtamaki et al. 2016, Vargo & Lusch, 2011, Polese, 2017).

According to Edvardsson et al. (2011), the concept of a service system has appeared frequently across SDL research streams in the context of service exchange. It was pointed out by Spohrer et al. (2007) that service systems are value co-production configurations of people, technology, and internal- and external service systems where information and resources are shared to create value. Based on the literature, the size of these service systems can range from a single person engaged within service exchange to an entire city or even a global economy (Spohrer et al., 2007). Furthermore, these systems operate similarly to social systems where participants collaborate with each other to improve adaptability and survivability, thus co-creating value for all parties involved. In other words, these systems grow and evolve to meet the needs of the business environment through this interactive process of integrating and sharing mutually beneficial resources (Edvardsson et al., 2011; Vargo et al., 2008).

That being said, the literature on value co-creation has a fundamentally relevant role in the process of understanding how different operators can interact and integrate resources to build an industrial cluster. This stream of research acts as a building block to understand the individual and system-wide motives that guide the exchange of resources and services through the beneficial viability of company profiles.

2.3.2. Processes and mechanisms

According to Saarijärvi (2012), the mechanisms of value co-creation are very distinctive in the sense that these represent avenues for a company to use additional customer or partner resources to support their value creation. The author highlighted co-distribution, co-development, and co-outsourcing as ways to integrate customer resources to enhance the company's product development, distribution, and sourcing processes.

However, it was also pointed out by Saarijärvi (2012) that not all companies or customers are interested in participating in value co-creation processes. This issue can be linked to the research of authors Vargo et al. (2008) and Edvarsson et al. (2011), which addressed the importance of mutually beneficial resource sharing to create economic value for both parties as an outcome of their integrated service systems. That being said, the evaluation of value co-creation mechanisms and their strategic feasibility for enhancing value creation is highly driven by the value proposition of such mechanisms to support the overarching business model of cooperating network actors (Saarijärvi, 2021).

Saarijärvi (2012) proposed that customer value proposition is an important strategic tool, which should be used for evaluating and assessing the benefits of a certain value-creation process or event. In essence, customer value proposition encompasses the unique selling points (USP) a company is communicating to the external market environment and the internal processes tailored towards the effective delivery of said USPs. Hence, Saarijärvi (2012) argued that the value creation mechanisms such as co-distribution, co-development, and co-outsourcing are always subordinates to the overall delivery of customer value proposition. The research of Grönroos (2012) further highlighted that even the sale of physical products follow this process, since the

total cost of product include for example logistics, maintenance, customer training, invoicing, engineering, software upgrading and recycling. In other words, multiple aspects are influencing the value creation process and the mechanisms used should not harm the delivery of customer value proposition for any of the parties involved. Thus, finding the correct partners for effective value co-creation can be difficult if there are no clear benefits such as cost reduction, energy efficiency,
and improved customer experience to be attained through the use of value-creation mechanisms (Saarijärvi, 2012).

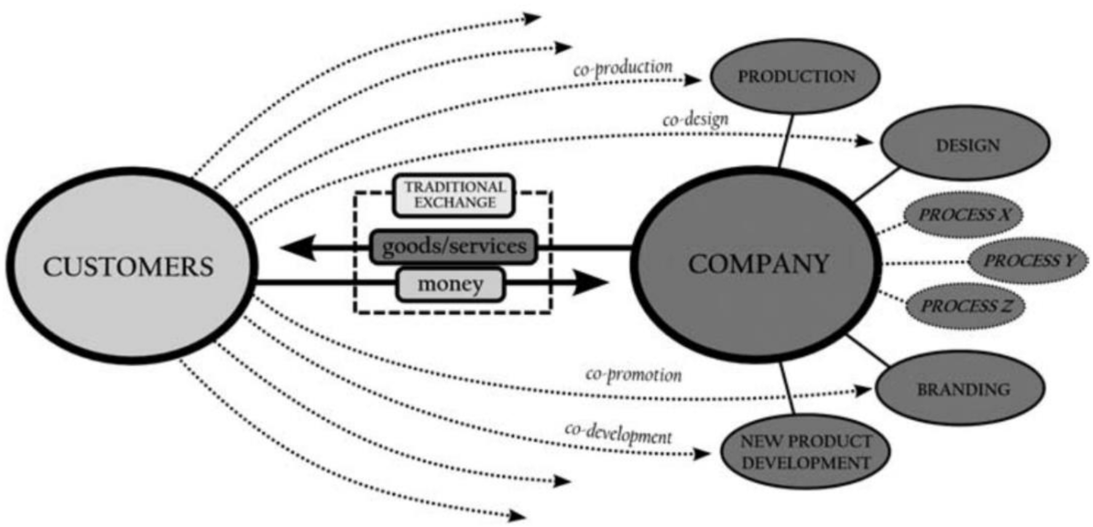

Figure 6. Going beyond traditional exchange – identifying different ways to engage customer resources in the company's processes (Saarijärvi, 2012).

2.3.3. Business model integration

The authors Nenonen & Storbacka (2010) have studied the evolution of value creation from the perspective of a single manufacturing company towards value co-creation across several network actors through the sharing of resources. However, Nenonen & Storbacka (2010) argued that there is a gap within value creation literature as it does not explain the type of resources companies can have and what is the interface to co-create value. Based on this, the authors investigated the business model concept as a construct to explain how companies interact with their customers, partners, and suppliers across the value chain and share resources to create value (Zott & Amit, 2003).

According to Nenonen & Storbacka (2010), the concepts of value creation or value proposition appear as core elements in business model literature. The building blocks for these are elements such as revenue model, structure of the value chain, resources, capabilities, target market, and competitive strategy, which together constitute the overall value proposition of the company. Thus, the effective implementation of value co-creation is affected by the internal configuration of business model elements and the external fit between business model configurations of different network actors (Saarijärvi, 2012; Nenonen & Storbacka, 2010).

Authors Vargo & Lusch (2008) have argued that there would be a need for a general theory of the market, which would shift the neoclassical market view of exchanging value towards co-creating entire markets and integrating resources in networks to create value. Storbacka et al. (2008) have built on this notion by suggesting “that market actors negotiate through their business models which aspects of their resource and capability configurations are used or how these interact for value co-creation”. According to Storbacka et al. (2008), business model will have a key role in explaining how market configurations are formed and evolve over time. In essence, this would mean that the combability of business models determines which actors can enter the market, and changes in one actor’s business model can transfer to the other actors’ business models, thus changing the entire market configuration (Storbacka et al. 2018).

2.3.4. Merging of value co-creation and ecosystem concepts

It has been established by previous research that the process of value co-creation is essentially different actors participating to reach certain goals. Hence, it could be argued that the value co-creation research also has close ties to the ecosystem research streams through understanding the interrelations between stakeholder networks (Lappi et al., 2015). Thus, combining these two streams of research could support sustainable development by providing the lenses through which we can understand the motivations and implications of network-wide cooperation.

Polese et al. (2017) researched merging the contribution of S-D logic and viable systems approach (VSA) with ecosystem theory, to reflect on “viable value co-creation" as a concept that could define the nature of the ecosystem. Both S-D logic and VSA highlight the important relationship between different systems and actors. The behavior and interconnected dynamics between entities are the driving force behind determining the nature of the ecosystem. That is to say, the relationships between actors outside a firm reflect the intensity of cooperation, which is critical for innovation and sustainable development. The infrastructure and culture of a firm can either accelerate or inhibit the spread of ideas and affect the development of new services and reusable solutions (Polese et al. 2017, Barile et al. 2016). The merging of S-D logic and VSA theories with ecosystem theory would suggest that the outside collaboration between different actors and their conduct within the internal system has a significant impact on the future development of the ecosystem.

The research of Spring & Araujo (2017) has been able to further develop the understanding behind value co-creation and ecosystem research by focusing on the product lifecycle to conceptualize the stages and processes for stakeholder cooperation. According to Spring & Araujo (2017), product identity is not stable throughout the product life-cycle but evolves through multiple stages of qualification and valuation as it progresses through potential refurbishment, remanufacturing, dismantling, re-use, and recycling. In other words, each stage of qualification provides an opportunity for network actors across internal- and external systems to cooperate and co-create value. For example, to create a closed-loop system for biocomposite cutleries, there are multiple different stages of qualification to consider. Firstly, the sourcing- and development of raw materials to meet the quality-, safety- and sustainability requirements. Secondly, the production of cutleries and packaging materials following the customer and service requirements. Thirdly, a possible organization of collection, washing, and reuse as a part of a service system. Finally, sorting the cutleries for recycling at the end of life, while also ensuring that issues such as food contact safety are addressed as a part of the material purification process. That being said, each of these stages may require a certain level of infrastructure or system-wide cooperation to be successful, thus resulting in resource sharing and integration, consumer involvement, and technological development.

Therefore, the ecosystem- and value-creation concepts together with VSA and S-D logic theories are highly relevant for the interplay between stakeholders while product biography helps define the model for cooperation. In other words, these theories provide an avenue for analyzing the different stages of product- and material cycles while establishing necessary internal system capabilities and external network relationships. When considering the overarching goal of a sustainable future in the context of reusable products, and the ecosystem these operate in, it is evident that a single actor cannot solve the nationwide issues relating to pollution, wastage, and usability. In contrast, participation across different industries, governments, and research institutions is required, and these theories can serve as a building block toward understanding the paradigm.

2.3.5. Sustainable value co-creation process

The concept of sustainable value creation process holds an important role in this research by creating a connection between concepts of circular economy, industrial clusters, and value co-creation. In other words, it explains the vertical relationship between different actors of a value chain and how improving this vertical interaction- and communication could potentially allow industries to develop more sustainable products and services.

The concept of a sustainable value co-creation process has been researched by Lacoste (2016) who found that S-D logic could be applied to the physical products at different stages of the product life cycle (Giarini, 2000). In essence, the development of a sustainable product should be based on the customer network interacting with the supplier network to drive change in consumer behavior and willingness to adapt towards the use of sustainable alternatives. Followed by customers taking an active role in the use of sustainable products and end-of-life processes such as recycling (Simula et al. 2009). It was proposed by Lacoste (2016) that to fully understand all the network actors involved in a sustainable value co-creation process, the entire product lifecycle beginning from the development of a solution to the production and end-use should be split into different stages. The S-D logic theory could then provide the foundation for understanding how different actors from supplier- and customer networks interact and what are the mechanisms for resource management throughout this entire process (Lacoste, 2016; Cova & Salle, 2008).

Lacoste (2016) used the sustainable product and service development (SPSD) method by Maxwell and Vander Vorst (2003) to map out how sustainability could be studied and optimized throughout the entire product lifecycle. Lacoste (2016) suggested that the sustainable value proposition in the B2B context is the outcome of companies successfully creating a link between customer- and supplier networks. In relation, Lacoste (2016) developed the sustainable value co-creation framework by building on the SPSD method and further introducing two levels of interaction. The first level of interaction is focused on the marketing of a sustainable product and changing consumer behavior which also acts as a catalyst for the development and production within the supplier network. The second level of interaction is focused on the actual functionality and end-use of the product as part of the customer network's service offering. In other words, the customer network will first create awareness and understanding of consumer behavior and the supplier network will deliver the appropriate solution that addresses the customer expectations through improved performance or supply chain integration (Lacoste 2016). Thus, successful interaction and sharing of resources between supplier- and customer networks could theoretically lead to a sustainable value proposition that creates increased value throughout the value chain.

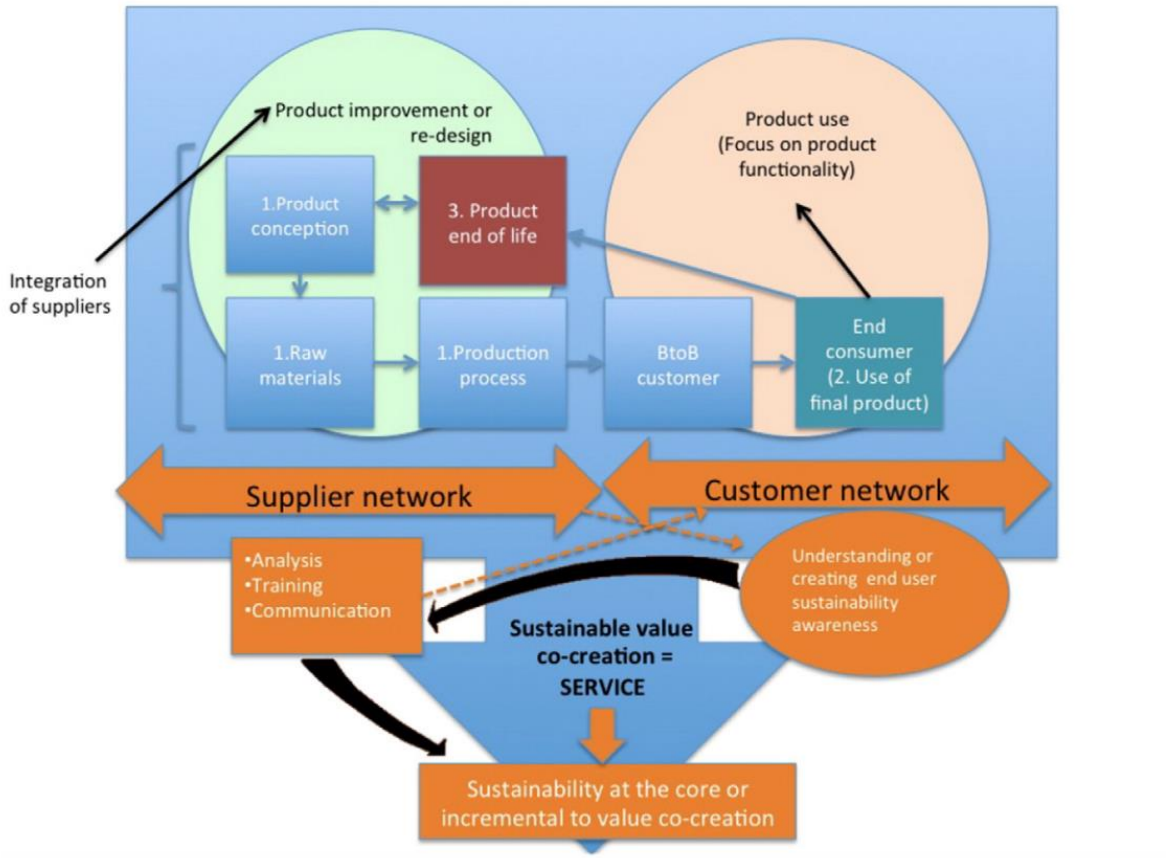

Figure 7. Sustainable value co-creation research framework in B2B (Lacoste, 2016).

2.4. Synthesis

Based on the research that was conducted on the existing body of literature, it can be concluded that the EU is quickly shifting towards widescale implementation of circular economy strategies to support long-term sustainable development (Corvellec et al. 2022; Kirchherr et al. 2018; European Commission, 2022). The development of industrial clusters through value co-creation has also gained attention in the literature as a pathway towards the development of sustainable business models (Baldasarre et al. 2019; Lacoste, 2016). This section will synthesize the key findings of this research area to assist in the theoretical framing of this research.

Importance of industrial clusters

Based on the existing literature, industrial clusters play a key role in sustainable development by fostering collaboration, innovation, and resource management within a specific geographical area it operates (Korhonen, 2000, 2001). Highly functional industrial clusters facilitate the effective exchange of knowledge, expertise, and resources between their network of stakeholders (Baldasarre et al. 2019; Boons et al., 2014, 2011; Chertow, 2007; Massard et al., 2014). Thus, industrial clusters can address sustainability issues and drive economic growth following the circular economy principles through network collaboration

Circular economy principles

The fundamental principles of circular economy are to minimize waste, optimize resource usage, and create a sustainable value chain. This is achieved through actions such as resource sharing, recycling, and remanufacturing, which could be addressed through the development of industrial clusters. Thus, the advancement of circular economy strategies can be directly linked to the development of inter-organizational networks of companies and finding solutions to potential issues relating to resource management, integration, and collaboration (Lahti et al. 2018; Ellen MacArthur, 2013; Stahel, 2010).

Importance of knowledge exchange and collaboration to co-create value

The development of inter-organizational networks of companies or industrial clusters to enhance resource management and integration requires collaborative processes to co-create value. The value co-creation process has been acknowledged as a fundamental driver for the development of industrial clusters and holds an instrumental role in fostering innovation, sustainable practices, and the creation of new circular economy opportunities (Nenonen & Storbacka, 2010; Arnould, 2008; Lusch and Vargo, 2006; Storbacka et al., 2008; Vargo, 2007; Vargo and Lusch, 2008b). Theoretical frameworks of value co-creation can be considered as a fundamental part of this research to understand overarching reasons that guide the development of industrial clusters within an ecosystem. By utilizing these frameworks it is possible to study what type of resources are needed and what are the mechanisms for sourcing or developing these resources within the industrial cluster (Lacoste, 2016; Cova & Salle, 2008).

Challenges and barriers

Although the existing literature has identified significant market potential from the development of industrial clusters through value co-creation, there are also severe challenges and barriers to be addressed. The research has shown that companies looking to build competitive advantage through cooperation can find it difficult to locate partners that possess suitable resources, business model configuration, or interest in cooperation (Lappi et al. (2015; Saarijärvi 2012). Furthermore, depending on the industry, it can be difficult to attain the suitable infrastructure or technology required if this is not readily available through local partners (Kirchherr et al. 2018; Preston, 2012; Shahbazi et al. 2016). There is also the social- and economic aspect that might influence the overall demand for sustainable products or services, thus impacting the feasibility of certain investments and negatively affecting the development of an industrial cluster (Corvellec et al. 2022; Kirchherr et al. 2018; European Commission, 2022).

However, as discussed, government policies and regulations hold a key role in fostering the development of new industrial clusters and supporting circular economy initiatives. The current literature has effectively established that the policy frameworks designed to incentivize sustainable practices encourage companies and consumers to adopt circular economy principles (Lahti et al. 2018; Corvellec et al. 2022). Thus, facilitating the necessary support and coordination required for value co-creation within industrial clusters.

Theoretical framework

Based on the existing literature, it can be stated that the European Union is actively moving towards widescale implementation of circular economy strategies. Replacing single-use items with reusable alternatives is one of the key initiatives and provides a strong foundation for the relevancy of this research paper. The development of industrial clusters can significantly improve the successful implementation of circular economy initiatives if resource management and barriers to collaboration are addressed effectively. Therefore, this research paper is specifically focused on addressing the barriers as well as resources and mechanisms of collaboration needed to successfully build a closed-loop system for reusable cutlery within the QSR sector.

The illustrated theoretical framework (Figure 8.) visualizes the roadmap toward successfully building a closed-loop system within the QSR sector by addressing the most notable contributions of the existing literature as well as the gaps in current knowledge. The research aims to build on the findings of authors such as Kirchherr (2017) and Corvellec et al. (2022) to understand the case-specific barriers to a circular economy through the development of a closed-loop system. However, the work of Lacoste (2016), Giarini (2000), and Simula (2009) hold a central role in understanding how the interaction between customer and supplier networks can contribute to the implementation of sustainable products and end-of-life processes as a part of a closed-loop system.

The research aims to find solutions to the identified barriers of a circular economy (Kirchherr, 2017, Corvellec et al., 2022) and challenges relating to the active involvement of stakeholder networks (Lappi et al. (2015; Saarijärvi 2012). This is achieved by addressing the case company-specific challenges and limitations across the different stages of the product life-cycle and promoting resource sharing and collaboration mechanisms within the cluster following the SD-logic theory. These findings provide lenses for understanding the higher-level strategic initiatives that guide the overarching development of the closed loop system.

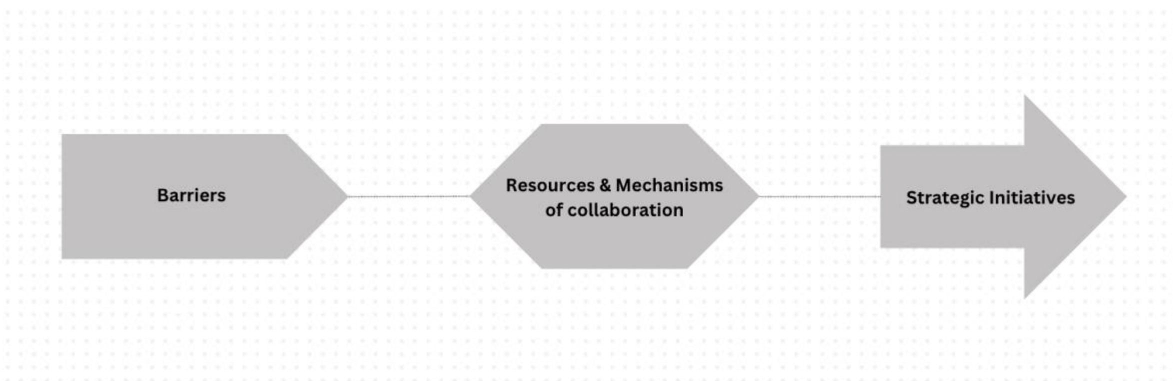

Figure 8. Visualization of the theoretical framework (Miska Kaskinen, 2024)

3. METHODOLOGY

The methodology used to conduct this research is a single-case study approach, which investigates the resources and mechanisms required to establish a closed-loop system for reusable cutleries within an industrial cluster. The research strategy has a close resemblance with the multiple-case study method since it analyzes several case companies within a single industrial cluster. This section highlights the relevance of the single-case study approach for this specific research context and justifies the research strategy by drawing on the existing literature.

3.1. Research strategy and method

The multiple-case study approach has been widely utilized in research as a method of analyzing complex phenomena in a natural context (Eisenhardt, 1989). According to authors Eisenhardt (1989) and Yin (2009), a multiple-case study approach has been found beneficial for research focused on investigating complex phenomena within real-life settings without clear boundaries. Eisenhardt (1989) has highlighted this method for its ability to generate rich and detailed insights to enhance the external validity of findings. Additionally, the work by Cook and Campbell (1979) further substantiates the method's utility in establishing plausible causal relationships and enhancing internal validity. This research strategy utilizes these key elements from the multiple-case study approach to strengthen the validity of the single-case study approach when analyzing several companies to provide a better understanding of industrial clusters.

Given the contextual nature of industrial clusters and closed-loop systems, the chosen research approach provides an effective means for studying the interplay between different factors within a real-world context. By investigating the individual processes and needs of different stakeholders, a more comprehensive understanding can be developed by examining the phenomenon from multiple dimensions. Thus, developing a holistic understanding of the requirements and processes needed from an individual stakeholder perspective, while also accounting for the interconnections and dependencies between stakeholder networks.

The ecosystem-, industry- and company-specific differences highlighted in the research underline the complexity of resource management and collaboration. However, given the specific focus of this research context, a more holistic view has to be taken as opposed to the traditional single-case study approach. The method is adapted towards a thorough examination of closed-loop system processes as we are analyzing the different stages of product lifecycle from raw material development to end-consumer usage and recycling. Thus, we are not analyzing individual entities, but several case companies and consider the overarching interconnections and dependencies within the industrial cluster. Therefore, the industrial cluster can be considered as a single case including several companies.

The established research strategy allows in-depth exploration of key knowledge, resources, and expertise needed to support the closed-loop system throughout the different stages of the product lifecycle. The utilization of a qualitative approach allows this critical information to be gathered directly from relevant stakeholders such as the forest industry company, product manufacturer, QSR restaurant, and logistics company. The use of precise case selection and interviews together with qualitative data analysis enable the collection of rich and diverse data from multiple different perspectives. Thus, allowing critical analysis of different perspectives, experiences, and perceptions of stakeholders related to the value co-creation processes across the entire product life cycle of reusable biocomposite cutleries. This also aligns with the foundational frameworks of Pettigrew (1973) on the dynamics of organizational decision-making, which can provide deeper insights into the interplay of resources within industrial settings.

3.2. Case selection

The relevant case companies are specifically selected based on their industry sector and role within the industrial cluster to support the development of a closed-loop system. Each case represents a pivotal stakeholder with a key role in the product lifecycle for reusable biocomposite cutleries within the QSR sector. The interviews are designed to capture key insights relating to the identification of commonalities, differences, and underlying mechanisms that contribute to the successful establishment of a closed-loop system. Yin's (1994) assertion on the importance of case selection underscores the methodological choices made here, aiming to enable analytical generalization from the findings. However, to protect the anonymity of case companies and their representatives, this research paper cannot disclose the names of the companies interviewed in the study.

The first case company is a forest industry company responsible for the development of biocomposite raw materials used in reusable cutleries. This forest industry company is responsible for the sourcing of raw materials and developing the biocomposite, but could also be considered as the recycler of the raw material if there are no ready recycling streams for biocomposite available. The second case company is the manufacturer of reusable biocomposite cutleries and is responsible for developing end products that meet the requirements set by customers and the regulative environment. The third case company is a QSR restaurant chain and is responsible for enabling the efficient utilization and collection of reusable cutleries as a part of its service delivery.

The case selection draws from the guidelines for analytical generalization to address the recent changes in the EU regulation and the impact on the QSR sector (Yin, 1994). The changes in EU regulation (SUP Directive, PPWR) are set to disrupt the QSR sector within the near future by enforcing the use of reusable cutleries inside restaurants to support the circular economy. The focus of this research is to investigate what are the key resources and collaboration mechanisms between stakeholders needed to address identified barriers and challenges to develop a functioning closed-loop system.

3.3. Data collection

The data collection implemented semi-structured interviews with key informants from each case company. The interviewees were selected based on relevant positions and understanding to provide insights on the key resources and mechanisms for collaboration needed to address the identified barriers and challenges to build a closed-loop system. The interview questions were based on the interview outline that was derived from the research on existing theoretical literature.

The method of data collection was a combination of video interviews and email questionnaires based on the availability of interviewees. In both scenarios, interviewees received open-ended questions with supporting instructions and an overview of the topic area to ensure optimal conditions for quality data collection. This method of data collection has also been shown to enhance the construct validity of research through data triangulation which refers to the use of multiple data sources and collection methods (Denzin and Lincoln, 1994).

The interviews and questionnaires aimed to explore the case-specific perspectives, experiences, challenges, and strategies related to the development of an industrial cluster supporting the effective utilization of reusable cutleries within a closed-loop system. The chosen method of data collection allowed an in-depth view of the interconnections and dependencies affecting the system through the lenses of an individual stakeholder.

Case Study	**Interviewee**	**Collection Method**
Forest Industry company	Director	Interview
Manufacturer	Sales Director	Interview
Quick Service Restaurant	Quality Assurance & Supply Chain Manager	Questionnaire
Logistics Operator	Business Area Director	Questionnaire

Figure 9. Data collection table (Miska Kaskinen, 2024).

3.4. Data analysis

The data analysis process used in this research was a combination of qualitative methods aimed at finding new insights from the data without guiding the research with the current theoretical findings. Both the Gioia method (2012) and thematic analysis (Castleberry & Nolen, 2018) are utilized to analyze the data and categorize these into key themes based on the identified key resources and mechanisms of collaboration. The approach taken resonates with the guidelines provided by Pettigrew (1973), who highlights the importance of extracting patterns and understanding the natural flow of organizational life.

The data analysis process began with the clarification of the research question that was drawn from the existing literature through secondary research. It was also noted by Gibbert et al. (2008) that without clear theoretical logic and careful operationalization, there can be no meaningful external validity. The following stage in the data analysis process was reading interview data and highlighting any patterns and key findings relating to the resource management and collaboration mechanisms that correspond with the research objectives. After identifying the key patterns, the data was grouped into first-order categories, second-order themes, and third-order categories (aggregate dimensions) based on the Gioia method (2012). This data structure was created to define the barriers and challenges at the case company level as well as higher-level themes for case-specific key resources and mechanisms of collaboration that were identified through the empirical research. This data structure is represented in the findings section of this research paper.

In the next section, the empirical findings are discussed using within-case analysis to test the research question that was derived from the existing literature on the individual case companies. The findings from individual case companies were cross-analyzed with existing literature to identify interconnections and dependencies within the industrial cluster. Thus, responding to the research question on the potential barriers and vehicles for resource sharing, integration, and collaboration.

Finally, the case-specific findings are synthesized across the aggregate dimension to effectively respond to the primary research question and create a blueprint for the QSR sector to start implementing reusables within a closed-loop system. This is achieved by establishing the key resources and mechanisms needed to coordinate effective development, re-utilization, and recycling of reusables across the different stages of the product lifecycle.

3.5. Validity and reliability

The validity of research findings is supported by the relevance and position of case companies within the ecosystem. Gibbert et al. (2008) highlight that the absence of nonrandom or systemic error is a crucial element of research validity, thus internal and construct validity are prerequisites for external validity. The chosen interviewees possess very specific expertise in their field, which can be considered as an instrumental component to derive meaningful insights from the research.

The key limitation of this research could identified as the data collection method. It was highlighted by Gibbert et al. (2008) that any compromises in data collection methods should be transparently acknowledged to ensure research reliability. Due to the limited availability of key personnel in case companies for interviews, this research had to make compromises in terms of the data collection method. Two interviewees from case companies were open to answering interview questions through email and two interviewees were open to attending a recorded meeting. This will be acknowledged in the limitations of this research as an event that may have implications on the overall depth of interview data and findings through lack of elaboration on certain topics to find a deeper meaning.

However, following the considerations of Scandura and Williams (2000) on the importance of research rigor, the research was conducted using good research practices and interview techniques to ensure the validity and reliability of the data. The interviewer himself has taken a passive role to separate individual opinions or assumptions from the research to avoid bias.

4. FINDINGS

4.1. Within-case description and analysis

4.1.1. Case 1: forest industry company

The case company provides insights into the challenges and strategies associated with creating a closed-loop system for reusable biocomposite cutlery. Their position in the forest industry and the role of material supplier situates them at the very beginning of the product lifecycle with a significant impact on the sustainability and development of closed-loop systems. The company holds a pivotal role in the development of new renewable solutions that support the global sustainability objectives of reducing waste and lowering carbon footprint.

Data structure & patterns

Qualitative data analysis was used to categorize and interpret the data, facilitating a deeper understanding of the underlying mechanisms driving the adoption and implementation of sustainable practices in the industry. A combination of thematic coding and Gioia analysis revealed patterns related to stakeholder engagement, barriers to circular economy adoption, and strategies for overcoming these challenges. This provides insights into the complex dynamics of creating a closed-loop system for reusable biocomposite cutlery. Furthermore, the data analysis highlights how the research findings are offering a comprehensive overview of the key factors influencing the lifecycle and sustainability of biocomposite materials within the industrial cluster.

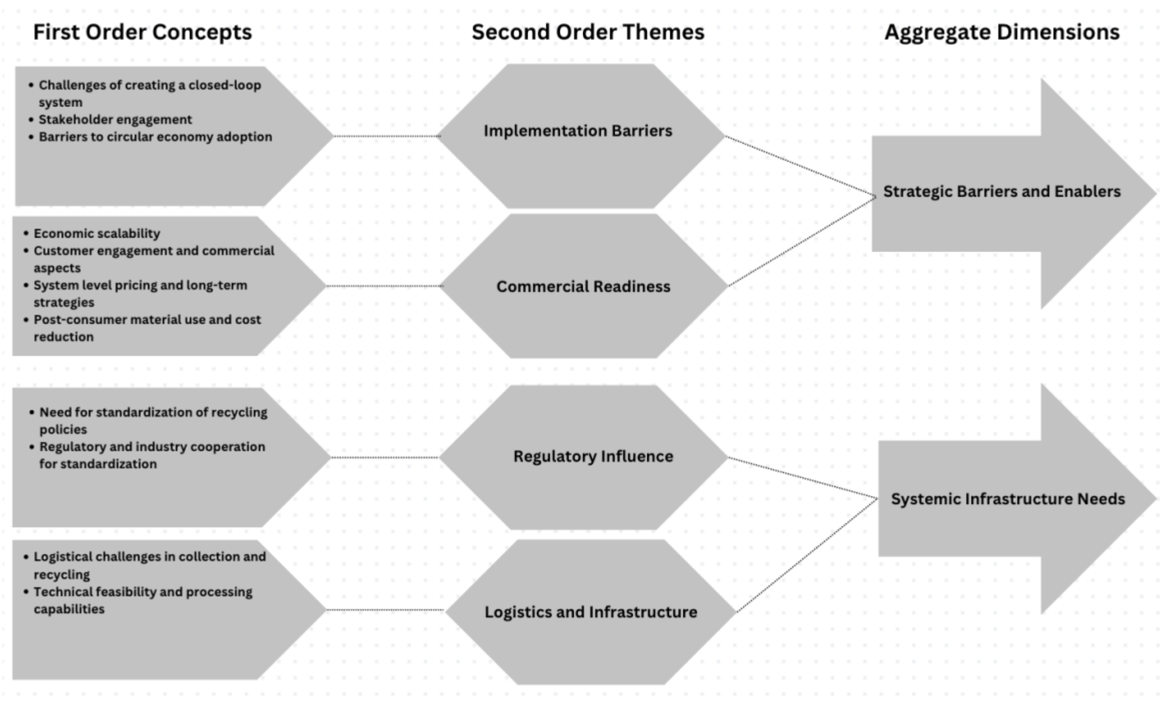

Figure 10. Forest industry company case study data structure (Miska Kaskinen, 2024).

Commercial readiness & implementation barriers

According to the interviewee, the development of closed-loop systems and the advancement of a circular economy do not require any new technological innovations concerning their raw material or relevant systems and processes to ensure a fully functional closed-loop system. In other words, all the technical capabilities are already existing and fully operational, but these should be harnessed towards the processing of new types of materials as a part of the closed-loop system.

”This process is existing, there are closed loop systems existing in the even food relevant industry with the fossil solutions already and that needs to be set up in the same way for the biocomposites.”
”So the biocomposites do not have any kind of limitation per per say.”

”The limitation is caused by how thoroughly this process is set up and the process needs to be set up in the same way that that it's set up for the, for the fossil-based, the industry when it comes to food to food approvals.”

Figure 11. Forest industry case company quotes (Miska Kaskinen, 2024).

The findings of the interview highlight how the forest industry company has been a forerunner in the field of circular economy. Their solution has been tailored from the very beginning to address the resource consumption and carbon footprint of existing materials with a fully recyclable stage 3 carbon-neutral solution. The focus of their product development has been to create a fully recyclable solution, where the performance does not deteriorate in post-consumer material when melted and processed into new products that can be fed into the ecosystem.

”I would say that the carbon footprint and this kind of carbon emissions in the future will come with a price tag. Especially when it comes to these kinds of CO2 reduction efforts that right at the moment are on discussion.”
”So leaving the scope one CO2 reductions what now have been done already in companies, they will be forced to work with the scope 3 considerations of CO2 footprints. And that means that even on a product basis you need to know what carbon footprint articles do have and not just the process, how you produce these articles, but on product level that the CO2 footprint that needs to be considered.”
”That means that it's not in the future anymore just this kind of promotional and responsibility argument that you that you that you pursue and that you promote. it's also the legislation that more and more forces companies to come up with these kinds of sustainable solutions and carbon neutral solutions and that's the only way you could comply with when you use these renewable-based materials.”

Figure 12. Forest industry case company quotes (Miska Kaskinen, 2024).

The interviewee explained that the main barrier has been the commercial aspect as well as the customer engagement since they would be able to implement the systems immediately given the customer interest. In other words, the higher price of biocomposite as a material rises to become an obstacle with some customers to kick off projects since they are not convinced that they would be able to pass on the increased costs to their customers. Thus, resulting in more cost-efficient fossil-based solutions becoming more attractive alternatives if the same outcome can be achieved at a lower cost. The interviewee highlighted that this type of thought pattern does not consider the system-level pricing which is essential for this type of materials. That is to say, while the total cost is higher at the start of the cooperation after the volume of post-consumer material increases through the circular process, then it is possible to achieve much lower costs. Effectively, the start of this type of system with partner companies requires a long-term strategy that considers the overall benefits over a span of five to ten years.

”If the customers would show the interest then we would have directly the possibility to start because we have already proven that there's an ecosystem existing and that we have partners we can work with. Then there is also the commercial part that is interesting in this whole approach because everybody understands that the biocomposites are a bit more expensive than the faucet-based solutions”
”And this is from time to time even a kind of obstacle and a kind of showstopper to kick off projects with some certain customers because they do not see the possibility to then pass on this extra cost, but they have to pay for the raw materials to their customers to make this more price competitive.”

Figure 13. Forest industry case company quotes (Miska Kaskinen, 2024).

However, the fact that the overarching benefits of the raw material can only be achieved at the system level, can also be considered as a significant barrier. Since the unique sustainability properties of the raw material demand a much higher price in comparison to the mainstream alternatives on the market, this can make it difficult to achieve economies of scale through mass adaptation, given the market dynamics. In contrast, if the adequate volume could be realized, then this could make it possible to utilize post-consumer recycled raw material, which improves the sustainability benefits even further while also making the price competitive to current alternatives at scale.

”You could really take this kind of post-consumer recycling materials into account and that's also how it was calculated the first time. We start with a certain volume of material and we have to pay X for this material in the beginning before it goes into this circular recycling process. “
“In the beginning, maybe 5% and then 10% and then 20% and then 30% and 50% of post-recycling material will be the virgin material. So that means that in the beginning, you have 100% of virgin material that is used for producing the goods. But over time you do not need 100% of virgin material anymore. You may just need 50% to produce these articles.”
“This then becomes a totally different calculation and if you calculate this then over a period of six years for example, you see that the system price is totally different and this system price is then directly competitive with standard solutions in the market.”

Figure 14. Forest industry case company quotes (Miska Kaskinen, 2024).

When considering the different options available, it is clear that the closed-loop system would have to be developed within a specific industrial cluster or through standardization of recycling policies for biocomposites to achieve the required scale. The industrial cluster-specific closed loop system would require agreement from very substantial market players to cooperate on the development of a closed loop system to start building collection and recycling infrastructure as it is not otherwise economically profitable. On the other hand, support from the EU level to standardize the recycling of biocomposites could result in a more easily scalable model toward the circular economy.

”In order to make a process profitable, you need to have a certain scale and you can start these kinds of pilots even on a local basis and a very limited regional approach, but it is a lot of effort and you will not come to a certain scale of economy with that.”
“To solve this, first of all, you need to have the proof that the capability of the solution allows this circle approach so that you could build up these kinds of pilots in the market. And that is also what we have started exactly proactively with our partner to really prove that in general, the technical feasibility is readily available. It can be converted, it can be treated, it can be even then reprocessed into products that are of the same quality of the same performance than with virgin materials”
”So that kind of pilots we could create ourselves proactively to influence the decision makers and this is where I look to the EU. There I look to even the kind of federal, federal institutes or regulatory authorities of every country to decide on collection and standardization systems, identification systems for the material to really influence these guys to come up with rules.”
”How to then label these materials, how to then identify or give a kind of identification of these materials to allow then the industry based on that standard to convert and reuse and bring these materials into the circle of production.”
”So it's two things, one that we already followed and the other thing is really influencing this decision the decision makers on the regulatory side as well as on credible institutions.”

Figure 15. Forest industry case company quotes (Miska Kaskinen, 2024).

Logistics infrastructure

The findings of the interview data highlight that the concept of recycling or the infrastructure in general is nothing new and technology has been available for decades. When considering the recycling of biocomposite cutlery as a part of the QSR sector ecosystem, the challenges related to the recycling surface within the topic of collection. That is to say, the most challenging aspect of recycling the biocomposite is to arrange collection points that make it easy and efficient to collect all the raw material for processing. When the biocomposite cutlery remains as a part of the industrial waste stream within QSR restaurant systems it is substantially less challenging to organize collection, but if these are part of the post-consumer waste streams due to consumers taking the cutlery with them from restaurants, then this becomes a significant issue for ensuring that all the raw material can be collected for recycling. According to the interviewee, this has been an identified issue since consumers tend to sort products into mixed waste within their household waste.

"You see also that recycling is a topic that has been in the market for decades already, it's a commitment question. It's a question of how committed customers are to implement this type of system to ensure correct end of life."
"The biggest issue at the moment comes not with post-industrial waste streams but post-consumer waste streams. The issue is how to dispose these materials to places where then converters could directly collect."
"If you think about cutlery, where it ends up, it, is normally in this in the household trash. So the limitation at the moment is who is building up this kind of collective or collection system, where this waste really can centrally be disposed and collected easily to bring them into the conversion system."

Figure 16. Forest industry case company quotes (Miska Kaskinen, 2024).

The interviewee also pointed towards a wider issue we are facing within the recycling industry as it is difficult to treat post-consumer waste in a centralized way where the collection and processing could be streamlined together with the logistics- and recycling partners. The interviewee stated that these challenges are surfacing from the lack of standards that would set clear guidelines for the sorting and recycling of materials. Given that the same type of labeling system as for plastic mono films could be implemented, then it would make it much more efficient for logistics- and recycling operators to organize waste into the correct category. For example, the pilot project of the case company has been successful precisely due to the ease of implementation due to their client managing the collection and shipment of products at the place of usage together with pre-defined logistics- and recycling partners.

Thus, the findings of this interview signal that the fastest route towards implementing a closed-loop system for biocomposite materials within the QSR sector could be through a collaboration set up within an industrial cluster and established systems and processes. This solution would allow industry operators to bypass the political challenges related to the standardization of biocomposite recycling on a national level.

”the technical capabilities to convert these materials, everything is existing. The issue for the whole recycling industry is how to treat the post-consumer waste in a way that it is collected centrally at certain places where these logistic partners can take this up and convert these waste streams then again into valuable products.”
”What has been done is that the industry created these mature identification systems for the recycling. So the class of material that is on ISO standard is also defined so the class 12345 for polypropylene, for example, 4 for LDPE. This kind of standard needs to be created so that when materials are disposed of they are clearly marked with also a standardized symbol so that the ones who are collecting and then sorting the waste directly can streamline these kinds of groups into a certain basket so that from there it could be taken up.”

“The local system that we have created with our partner works because these products can be considered as post-industrial waste because these are not with the consumers. These trays are still in the competency of this partner company and could directly be also then collected at the place where they are used.”
”The bottleneck right at the moment is really that when you produce biocomposite materials and it's ending up in the normal waste streams, it cannot really be identified as a value of the raw material that is worth to be put into a conversion process again.”
“We do not have enough people who are then collecting waste but this as of the reason that the standard is not created but we do have recycling companies that are able to grind that are able to create precursors for real producers of post-consumer recycling materials.”
”So this is all existing but what is really lagging is the standard creation how to identify and where to bring and and and centrally also collect the waste that is created to be then converted again this is for me the biggest issue right at the moment.”
“At the moment the recycling system only works properly for PET, LDPE films, or polypropylene films. We have existing recycling streams because these materials can be clearly identified and they are pure and therefore they can be easily then converted into raw materials again that are then fed back into into into the normal production of products.”

Figure 17. Forest industry case company quotes (Miska Kaskinen, 2024).

Regulatory influence

The limitation for recycling biocomposite has currently been the lack of awareness on who would build this entire collection system and make it operational to centrally dispose of biocomposite materials within the system to enable the conversion to new products. All the competencies required to build this system already exist and this only highlights the need for leading operators to take responsibility for advancing the initiatives, since no innovations have to be developed.

"If you have 1-3 of the big brand owners who then would decide, OK we are creating, we are not reinventing the wheel, but we are creating a process where existing partners with existing competencies are approached and are then integrated in a process that allows us to reuse these cutleries, multi-use cutleries in a way of reproducing them in a circular way into our new products."
"Then the economy of scale or the scale of the economy would be a totally different one."
"And it could also lead to the fact that these kinds of cutleries or products over time would become even, I would say more cost-efficient. But of course, it would reduce the use of of raw materials. It would reduce the carbon footprint."

Figure 18. Forest industry case company quotes (Miska Kaskinen, 2024).

Essentially, enabling the wide-scale recycling of biocomposite products on a national level requires a clear set of standards for identifying the different materials such as the biocomposite. Currently, there is no process for identifying it as a valuable raw material that should be collected and converted for repurposing. Furthermore, there also has to be a location to send all the materials for centralized collection and conversion. All of this is currently working with existing recycling streams for PET, LDPE, and PP films because these raw materials are pure and easily identified, sorted, collected, and converted into new products. The findings of this interview provide crucial lenses to understand the limitations that impact the development of a closed-loop system on a larger scale for biocomposites within the QSR sector. All the requirements exist, ranging from technology and processes to the stakeholder willingness to collaborate, but the key barrier to implementation is highlighted as the lack of standardization coming from the political level.

”So what would really support if these partners would team up and would create this kind of standard and this is what it's all about for the biocomposites – collecting, sorting, and conversion standards for their own industry that would allow the streamlining of these materials efficiently into these kinds of circular processes.”
”Because right at the moment the industry is pretty much relying on what already has been established and that is what the packaging regulations are really requesting and how they identify materials. They are not proactively trying to even adjust these kinds of existing regulations with a standard of their own that clearly describes ways of handling and reusing these biocomposites.”
”If it would be possible to bring all these people on one table and then say guys at the moment we are moving into these more sustainable materials. We could at the same moment really create a process, a circular approach that describes clearly the materials that are used and the treatment and the collecting and everything to bring them back into the process and bring them back into our goods to reduce the use of material, to reduce the CO2 footprint to reuse also these kinds of material usage that we normally have with the standard solutions or without such a process in place.”

Figure 19. Forest industry case company quotes (Miska Kaskinen, 2024).

4.1.2. Case 2: Manufacturing company

The case company is a Finnish startup specialized in manufacturing reusable biocomposite cutlery from forest industry side streams. This particular case reflects the evolving complexities of integrating circular economy principles into industrial practices. The interview data provides a comprehensive insight into the manufacturer's efforts in developing and enhancing the value of their biocomposite cutlery products to support wide-scale utilization within the QSR-sector.

Data structure & patterns

Thematic coding used in the analysis revealed specific challenges and strategies mentioned in the interview that were used to map out the broader themes that were highlighted such as product development, quality assurance and sustainability. Understanding the broader themes and categories allowed identification of aggregate dimensions that signify the most critical resource and collaboration areas for a development of a closed loop system.

The findings place recurring emphasis on product quality, customer education, and stakeholder collaboration across different themes as key drivers to support use of reusable biocomposite cutlery at scale. In other words, the findings suggest that the manufacturer is committed to not only improving their product but also fostering a broader shift towards a sustainable circular economy. This can be considered as a fundamental step towards the development of truly circular solutions that are based on more sustainable business models. The next step is to find ways to integrate these new sustainable business models to the existing ecosystem.

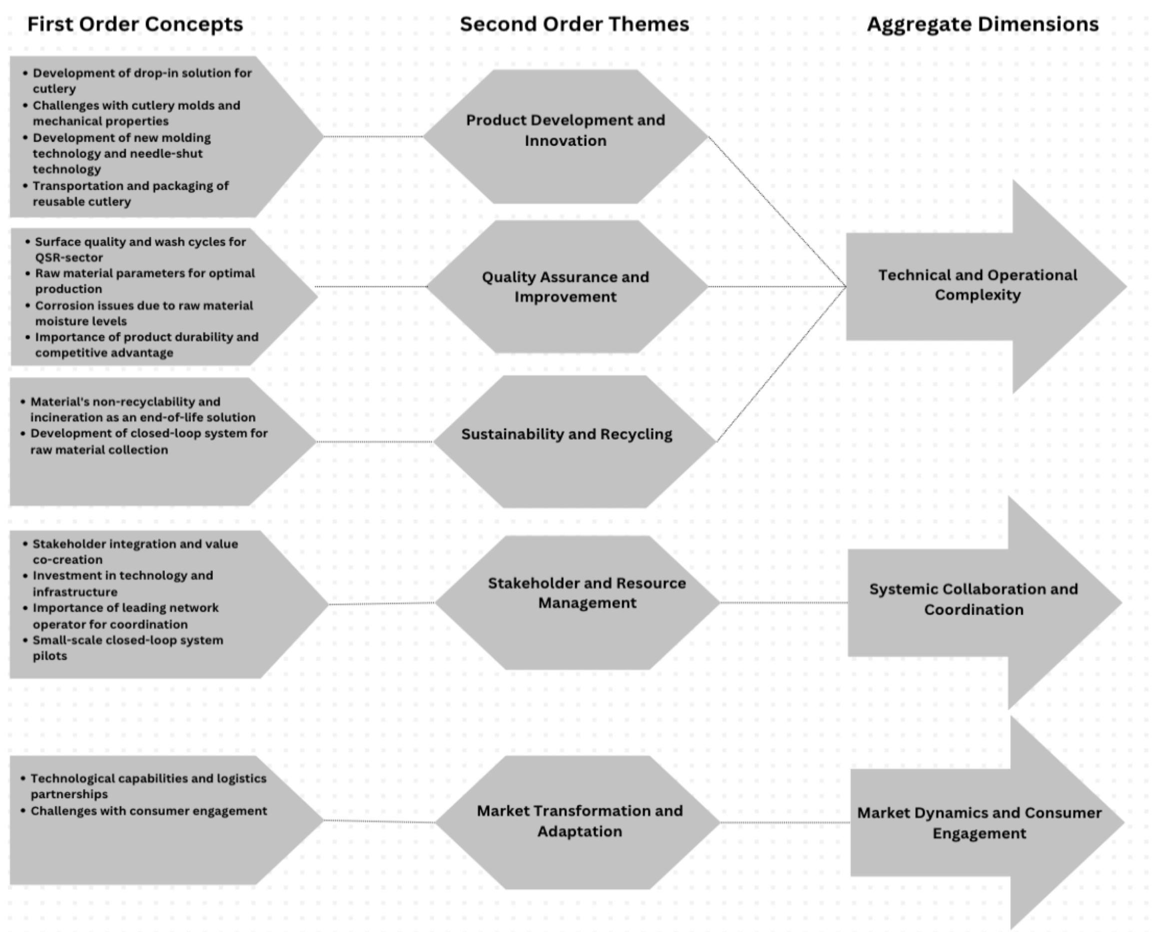

Figure 20. Manufacturing company case data structure (Miska Kaskinen, 2024).

Product development and innovation

The business idea to develop a drop-in solution for traditional plastic single-use cutleries was established in 2018 following a strategic partnership with Finnish forest industry giants. The idea was to utilize side-stream waste from existing forest industry processes to produce new products as a replacement for fossil-based plastics, even in food contact applications.

The initial challenge emerged from using existing plastic cutlery molds to create biocomposite cutlery as a drop-in solution without further consideration for the target sector (retail, HoReCa, QSR). Consequently, it was difficult to attain the required mechanical properties for end-use applications, which led to a comprehensive product development cycle to understand material properties and align production technology to complement this. For example, it was learned that the molding of wood fibre cutleries requires 2-2.5 times more pressing force in comparison to the 90-ton machines used with plastic cutleries to successfully create a functional product.

The manufacturer has since then developed completely new molds and pioneered the use of needle-shut technology to be used as a solution in the latest product ranges to achieve better product quality. This has supported the development of the necessary mechanical properties and surface quality to meet the demands of the QSR sector in repetitive use and wash cycles at scale.

"When we started processing these cutleries... it was technically challenging, but also it did not meet the quality or usability expectations of the QSR sector or other customer segments... We started modeling the cutleries completely anew for injection molding technology... This led to the creation of our current product ranges".

Figure 21. Manufacturing company quotes (Miska Kaskinen, 2024).

However, another challenge the company has faced is the transportation of dirty cutlery after use in case it is used within food-to-go applications. It has been evident based on the market research that consumers may find it difficult to safely transport such cutlery after use and it can be more convenient to dispose of single-use cutlery. The manufacturer has been working together with the packaging material suppliers to design a packaging prototype with a zip lock that would allow the packaging itself to be used as reusable packaging for the cutlery and solve the issue highlighted in the market.

“Price sensitivity is shifting the thinking of reusable packaging towards cheap paper flow packs with closable zipper lock… consumer would simply put the cutlery in the pack and close the zipper before putting in their bag and wash at home or leave at a collection site.”

Figure 22. Manufacturing company quotes (Miska Kaskinen, 2024).

Quality assurance and improvement

The product development and innovation discussed in the previous theme are closely tied to the quality assurance necessary for applications within the QSR sector.

The sales director of the case company further elaborated on this topic by pointing out that the most important aspect in terms of quality assurance for food contact applications is the surface quality of the cutlery. The developments in molding technology have been specifically addressing the diminishing surface quality during wash cycles due to the uneven distribution of wood fibre and polymer, leading to the release of lignin. It was highlighted, that the diminishing surface quality does not impose a food safety risk in the form of migration but rather alterations in visual appearance and mouthfeel.

"When we begin to develop closed-loop systems for the QSR sector, our product must really serve the QSR sector operator so that it circulates many times without losing surface quality features which could even cause loss of mouthfeel and such. So, I consider this one of the very large development targets".

Figure 23. Manufacturing company quotes (Miska Kaskinen, 2024).

The development of raw materials together with the forest industry operators has intertwined processes with production technology as the natural material has certain production parameters needed to run optimal production. For example, it was found that the molds would corrode if the raw material's moisture level was too high since the wood would start to eat the metal. According to the sales director of the manufacturing company, understanding the unique parameters such as viscosity and moisture percentage marked a groundbreaking shift in product development as they could develop processes in place to achieve the optimal parameters in production.

"When we understood this technology, the big leap forward in the development of the raw material began, that is, when we knew what kind of raw material it had to be. Viscosity, moisture percentages, and others were known when they arrived to us, after which we started our own viscosity cultures and drying processes to compare, but then the size of the fiber that did not fit into the system became a big problem. Shifting away from using any kind of sawdust from different sawmills became a huge project for raw material suppliers in 2020"

Figure 24. Manufacturing company quotes (Miska Kaskinen, 2024).

To meet the high-quality standards of the QSR sector, the cutlery manufacturer has been taking tremendous steps to ensure that the development of production technology and raw material work in symbiosis. The most critical development project in terms of meeting the requirements of the QSR sector and supporting the development of a closed-loop system is the surface quality of the cutlery. Several aspects ranging from the raw material properties to the actual injection

molding process can affect how the raw material behaves and whether this could cause issues in long-term use and dishwashing.
Therefore, a crucial focus has been on the durability of their products, especially their surface quality. This aspect is critical in the context of their use in closed-loop systems, where cutlery needs to withstand repeated use without compromising quality. The company's emphasis on enhancing the product's ability to endure multiple uses without quality degradation aligns with the sustainable practice principles and reflects a deep understanding of the functional requirements of their products in real-world applications.

The sales director of the manufacturing company argues that this type of product development to guarantee quality assurance is also a significant competitive advantage for the company. In other words, consumers go to QSR restaurants to enjoy food and when using cutleries that may not perform as intended or transfer tastes and odors together with the food, the total service experience diminishes.

"Consumers don’t go to buy either disposable or durable cutlery, they go to buy food and even a small distraction can cause this to be a disappointment. Meaning that not only its responsibility but what can be achieved with these modern high-quality products play a role"

Figure 25. Manufacturing company quotes (Miska Kaskinen, 2024).

Sustainability and recycling

The sales director of the manufacturing company discussed the sustainability of their biocomposite cutlery in length. It was highlighted, that the combination of reusability, low carbon footprint, and sustainable origin of raw material is well aligned with European sustainability objectives. However, it was noted, that currently their cutlery cannot be recycled due to the material being a polymer matrix containing two different raw materials. This type of material does not have readily available recycling streams that could be utilized to recycle the raw material at the end of life. Thus, the optimal end-of-life solution has been incineration where it is possible to be utilized as a renewable energy source.

A potential solution to this issue has been the development of a closed-loop system where the raw material supplier would collect the cutlery at the end of life for the production of new raw material. This solution has a few issues, which include the necessary resources and volume needed to arrange collection for the cutlery, but also the infrastructure to handle different streams of raw material. It was highlighted that the new virgin raw material and contaminated cutlery would require separate systems to avoid food safety risks, which would also mean additional investments.

"The compounder unit is currently unable to receive our cutleries for recycling due to it being too small facility... It was a pilot unit when it was started in 2019 and immediate contamination happens if dirty cutleries arrive there".

Figure 26. Manufacturing company quotes (Miska Kaskinen, 2024).

The idea to start developing capabilities for recycling or closed-loop systems has been on the table for a few years already with the manufacturer. To promote the development of actual recycling streams for biocomposite materials, it would be necessary to lobby these on an EU level to promote change. The other choice would be then to start developing a closed-loop system together with the operators within an industrial clusters. According to the sales director, they acknowledge that the active contribution of the manufacturer as a leading operator within the cluster might be needed to help develop the necessary systems for collection, recycling, and reuse.

Therefore, solving this fundamental issue of recycling is interconnected with the resources, capabilities, and cooperation between the raw material supplier, QSR operators, logistics providers, and government officials to coordinate the entire operation. The interview data suggests that the main concern for developing new recycling streams or purposefully building closed-loop systems will be effective stakeholder- and resource management as well as coordination. In other words, the technological capabilities and systems are already established but it requires a paradigm shift among stakeholders to repurpose it for biocomposite materials.

Stakeholder and resource management

The sales director has been able to identify various stakeholders that are deemed mandatory for the successful implementation of a closed-loop system within the QSR sector. These stakeholders include packaging material suppliers, logistics partners, raw material supplier, QSR operators, and their partners, and finally end users. The concept of stakeholder integration has been considered vital for closed-loop systems as these rely entirely on value co-creation from the stakeholder network.

However, one of the key points highlighted here was the need for significant investments in technology and infrastructure to support the necessary systems within individual sub-systems of each stakeholder and their processes. For example, the QSR operators would have to set up the washing, collection, and communication processes to streamline the use of reusable cutlery within their restaurants without sacrificing consumer experience. This creates a certain type of barrier for advancing circular economy initiatives without a joint agreement between stakeholders to take action. It is essential to have clear targets, goals, and metrics to be established for monitoring and understanding the successful implementation and capturing business value. In this regard, the sales director pointed out the importance of always having a leading network operator. Someone who manages and coordinates the development of an industrial cluster to ensure that systems and processes are aligned across the entire value chain and all stakeholders understand the mutual value presented.

"Behind a functioning closed loop, several actors are needed, but at a certain scale, even the relevant ones, like manufacturer and raw material supplier, can do something unique. It's very important to note... you always need a leading operator".

Figure 27. Manufacturing company quotes (Miska Kaskinen, 2024).

Nevertheless, it is also possible to create circular solutions even with limited resources when operating on a smaller scale. It is only with the wide-scale implementation that the need for a higher level of collaboration and resources becomes mandatory. The sales director of the manufacturing company was able to provide concrete examples from their previous endeavors for building small-scale closed-loop systems to validate the system.

For example, during the early days of the company in 2019, they were able to implement a small-scale closed-loop pilot project together with a forest industry operator in the UK by supplying MM tournament with cutlery and arranging collection points at the site. This closed-loop pilot successfully supplied- and collected reusable biocomposite cutleries from the event and repurposed the raw material for a new purpose at the end of life.

Another example of successful stakeholder cooperation was a partnership with a well-known retail chain in Switzerland to reduce plastic usage in the food-to-go sector by switching all single-use plastic cutlery to reusable biocomposite cutlery and reducing the total annual consumption from 40 million units to 20 million units. The results of this cooperation have been remarkable according to the sales director and they achieved this goal in 18 months. An independent market study by the retail chain suggested that the majority of consumers using the cutlery bought breakfast and lunch from a supermarket to eat at their workplace and this opened a possibility to promote re-use by removing all free alternatives and including a fee for the use of reusable cutlery. In case the total volume of meals bought has not decreased during the years, then the market study would suggest that the consumers are indeed using the cutlery more than once to eat at their workplace given that the annual consumption of cutlery has decreased by 50%.

In the context of the QSR sector, it was stated by the sales director that they have been trying to map out the relevant steps within the entire system and what type of aspects should be taken into consideration to arrange a closed-loop system for the QSR sector. The first step would be for the QSR operator to have an internal collection- and reuse system in place, which would allow consumers to return the used cutlery for washing. The washing would have to be arranged at the

QSR restaurant or possibly by a third-party operator specializing directly in the washing and logistics of the reusable tableware. Someone will have to build the collection system or bins that are used and then a logistics provider must arrange the pickups and storage for products before these can be sent to the compounder for processing. One question the sales director highlighted here was the capability of raw material suppliers to take used products for processing and if they have only limited windows of opportunity to prepare separate cleaning and processing for potentially contaminated materials. Essentially, this would mean that there should be a separate logistics hub that allows the collection of materials and then distributes these forward based on the processing capabilities of raw material suppliers.

"We already first launched the idea a couple of years ago, that we should be developing and bringing that contribution to how to get the closed loop system to work. For example, to help build such a collection system, where the QSR operator would have an internal built-in collection system for washing again if it is possible there. "
"To have a recycling system to which the consumer could return the products that they do not take home to be used again, we need a logistical partner and this is a significant development target since we need several stakeholders for it. First, the logistics partner or material supplier sorts the materials based on suitability for reuse. Then the logistics must collect these somewhere in a hub and transfer them to the compounder in large containers."
"There can be a specific time window to close the loop and set up a compounding line specifically for this type of contaminated material to be repurposed for reuse."
"One possibility could be to deliver this type of material to the compounder three times per year and this would need an external hub where used products from hundreds of restaurants would be delivered to every week."

Figure 28. Manufacturing company quotes (Miska Kaskinen, 2024).

It was also highlighted by the sales director that they already possess the technical capabilities to supply and collect even one box of cutlery from a customer such as a QSR operator through their strong logistics partner. Essentially making the closed loop possible from their side of the process. However, the customer or a QSR operator in this context, is the most critical component in this equation as their cooperation is needed to make it possible. Cooperation with QSR operators is essential to understand their requirements and limitations for being part of such a closed-loop system for reusable products. It is important to consider where the QSR restaurant operates and how could this impact the system as a whole. For example, whether the restaurant is located outside separately or inside a shopping mall can have a significant impact on the different mechanisms and solutions that can be implemented to collect and wash the reusable cutlery at scale.

"Before we can start planning any cooperation, we have to understand who is the customer, where they operate, and what are the possibilities for collection and washing processes."
"The manufacturers or suppliers of washing infrastructure for HoReCa-operators are also important stakeholders enabling reuse of cutlery – the machines have to be compatible for washing the reusable cutlery" *"I would also highlight proper IT-system as a necessity since you have to be able to account how many units are recycled, collected or end in waste streams".*
"The final important resource is communication as you have to educate the consumer on how to use the reusable products, how to dispose them and so on."

Figure 29. Manufacturing company quotes (Miska Kaskinen, 2024).

Based on the interview data, it is evident that the actual reutilization of reusable cutlery can be realized quite easily on the consumer level if they are incentivized to take action. However, when it comes to the industrial scale application within the QSR sector then there are more variables to consider to make it feasible for QSR operators to start implementing reusables as a part of their systems and processes. Finally, closing the loop and collecting the used reusables to be repurposed as raw material for new products is only a matter of making the process financially feasible for all the different stakeholders to participate.

Market transformation and adaptation

When considering the market drivers that are facilitating the change within QSR sector, it is evident after discussing with the sales director that this is first and foremost supported by the changes in EU regulations and legislations. However, the set deadlines that force QSR operators to start implementing reusable alternatives at scale are in 2030. Without any financial incentive, this timeline results in challenges to develop the new business segment ahead of the schedule within QSR sector.

The sales director emphasized high prices as a significant barrier to entry for the QSR sector as their cutlery is much more expensive in comparison to the single-use wooden cutlery. In addition, the development of systems and processes for washing and collecting reusable cutlery would mean even more additional costs. Thus, solving the high-cost barrier has been a significant focus area when discussing with QSR operators regarding a large-scale utilization of reusable cutlery. Consequently, if the QSR restaurant can re-use the cutlery at their restaurant and then receive new products made from the collected post-consumer raw material, they would be able to achieve substantial cost reductions while also benefiting from a lower CO2 footprint for their entire operation.

Another key component within the changing market environment is consumer acceptance of reusable alternatives to replace the single-use products on the market. Based on the interview with the sales director and preliminary market research it is clear that the consumers are not well aware of the topic, but they are also not very excited about the use of reusable alternatives. A key challenge that emerged was hygiene as consumers are questioning whether reusable cutlery can be hygienic even if it is washed at the site and the majority would prefer to have individually packed fresh cutlery if they would need to use one. Another challenge that is apparent to consumers is the convenience of single-use cutlery since they can dispose of these easily, and the fact that reusable alternatives need to be returned to specified locations was considered as potentially a negative aspect.

Thus, it is clear that even though EU regulation will enforce this change in the coming years, we still require adequate communication and education for both consumers and QSR operators to support the implementation of a streamlined closed-loop system. That is to say, communication with QSR operators requires a paradigm shift to start considering the use of reusables from a wider perspective rather than comparing the costs of individual consumables such as cutlery. The education and communication towards consumers have to be a coordinated effort from the stakeholders to streamline the processes and ensure that the shift does not negatively impact consumer experience within QSR-restaurants, but also so that the consumers can be involved as a critical enabler of the system. This is where the development of collection schemes, packaging innovations, and educational materials together with proper recycling guidelines are considered as key components of success.

4.1.3. Case 3: Quick service restaurant

This case study for the QSR-sector involves a significant global franchise-chain that is operating in Finland to understand their perspective on the use of reusable biocomposite cutlery and development of closed loops system to further support circular economy. This company is also an existing customer of the manufacturing company so the identified themes will provide direct feedback on the current use of biocomposite cutlery within QSR-sector.

Data structure & patterns

Based on the identified challenges and analysis of responses from the survey, broader themes such as limited implementation, operational challenges, consumer behavior modification and brand regulations were highlighted. The identified themes can be related to overarching concepts like implementation challenges and potential for cooperation.

The survey responses, while limited, indicate a pattern of challenges related to customer behavior, organizational constraints due to brand regulations, and a general lack of active involvement or strategic planning in the circular economy initiatives.

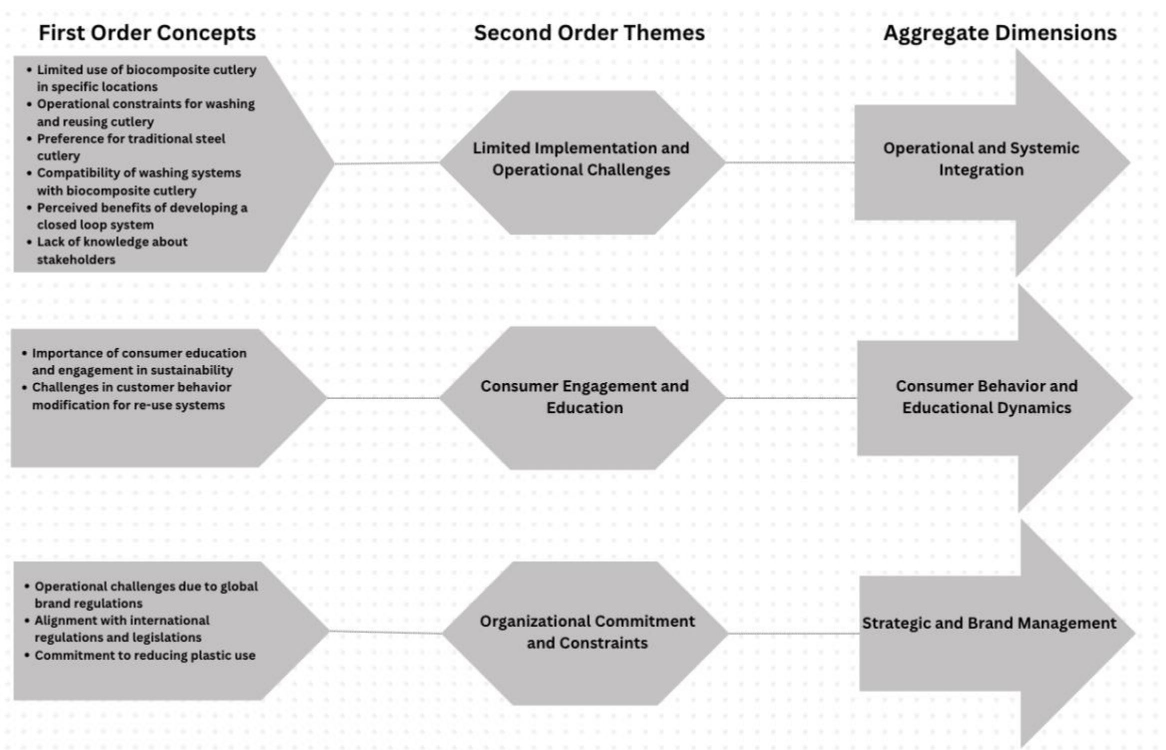

Figure 30. QSR company case study data structure (Miska Kaskinen, 2024)

Limited implementation and operational challenges

The quality manager of the QSR operator revealed in the survey that they are currently using the biocomposite cutlery in only one of their restaurant which is located in a shopping center. Furthermore, even though the cutlery could be used multiple times, these are currently used only as single-use cutlery that is disposed of after the use. According to the quality manager, the reason for this is the fact that the shopping center is responsible for the cleaning of the area. However, it was highlighted by the quality manager that they hoped there would be a change to this happening soon and they would be able to start washing and reusing the cutlery within the restaurant area. When discussing the other restaurants that are not operating in a food court area of a shopping mall, the quality manager revealed that they are using steel cutlery for the moment as these support their concept better than single-use cutlery.

"Actually, these are used like single-use cutleries, since one of our stores is located in the food court area in a shopping center and the area is cleaned by the shopping center. Hopefully, we can start using these like 'real' cutleries soon."
"For the moment we are using reusable (metallic) cutleries in our other stores. According to our concept, we'd like to use such cutleries instead of single-use ones. "

Figure 31. QSR company quotes (Miska Kaskinen, 2024).

The findings of this data analysis implicate that the wide-scale implementation of reusable biocomposite cutlery within the case company restaurants is highly affected by the restaurant location and the effect this may have on the collection and washing of the cutlery in case there are more stakeholders involved such as the shopping center. It is also presumable that the traditional steel cutlery is the preferred choice over all the cutlery alternatives given that there is a possibility to wash these. Furthermore, this also highlights that the system for washing cutlery can already be in place if the restaurant concept is built on the use of steel cutlery when dining in the restaurant. The question is whether the current system is compatible with biocomposite cutlery in terms of wash temperature or a tray system that keeps the cutlery in place during the washing cycle. Overall, this would suggest that the manufacturer of reusable biocomposite cutlery will have to provide a solution that is compatible with the existing system or provide enough value to make it feasible to invest in new machines. Nevertheless, given the strong market position of steel cutlery for dining inside the restaurant, reusable biocomposite cutlery will have to leverage strengths such as sustainability, lightweight, and potential cost savings in the long run when taking into consideration the system-wide benefits of a closed-loop system.

Consumer engagement and education

When considering customer engagement and education, the quality manager of the QSR-operator mentioned that this is one of the most significant challenges for an effective re-use system. In other words, effectively communicating the correct sorting of different materials to the end consumer and getting them to follow these instructions is considered to be very difficult. As a solution to this, the quality manager proposed specified collection bins with clear signs that indicate the collection of reusable materials that are washed for reuse and instructing the restaurant personnel to provide additional guidance to the end consumer during the service encounter.

"To convince users to put the cutleries into a correct bin = not the usual bin into which the ordinary single-use packaging is put into."
"Separate bin visible enough with a clear message. Perhaps also our personnel should inform people about the possibility of reuse."
"I see that adding information and defining a clear process for customers to return the cutleries may be the key actions."

Figure 32. QSR company quotes (Miska Kaskinen, 2024).

These findings highlight the need for an effective collections system that is incorporated together with adequate messaging targeted toward the end consumers to get them actively involved in the process. However, this also brought up a new element that can be considered as a barrier - the employee training and setting up established processes to follow.

Organizational commitment and constraints

The survey with the quality manager revealed that one of the most notable constraints for a global QSR operator on a local level is the very strict global brand management, which guidelines for all the operations. For example, cooperation between the QSR operator and different stakeholders to develop new innovative solutions to promote circular economy can be difficult as the global brand owner has strict regulations for the products on a global level.

> *"Could be more active. Our brand owner YUM! has quite strict regulations on our products at the global level."*

Figure 33. QSR company quotes (Miska Kaskinen, 2024).

It was highlighted by the quality manager that sustainable development and advancement of circular economy is very important for the brand on a global scale but everything has to be approved by the global brand owner. Thus, they are very closely following international regulations and legislation, but starting new initiatives can be difficult and slow to start if these are not enforced by law. For example, as a company, they are currently committed to reducing the use of plastic and improving the plastic recycling rate as a part of their operations since this has been a key initiative globally.

However, as a food service operator, they are also highly affected by food safety regulations and this is an aspect that greatly influences setting up any new systems, or processes or introducing new products to promote sustainable development. For example, the biocomposite cutlery and processes to collect and wash these must be qualified and approved according to food safety guidelines set by the global brand owner. These guidelines are drawn from the regulations and legislations of the governing body in a set country, such as EU regulations in Finland. These types of strict processes set up certain barriers to developing new sustainable business models and must be taken into consideration when developing new innovative solutions that require extensive stakeholder cooperation.

That being said, the quality manager considers the development of industrial clusters and a closed-loop system for biocomposite cutlery a positive development in general. However, she highlighted that it would be essential to have a clear and efficient setup as well as a large enough pool to make it operationally effective. The quality manager pointed out that she does not have adequate knowledge about the relevant stakeholders needed to comment on the topic, but assumed these are similar to the Finnish Palpa-system. The lack of these relevant stakeholders or active communication and cooperation was still apparent and assumed to cause of slow development for any new systems to support the circular economy.

"Positive opinion. If we'd have clear, efficient set up and the and the pool is big enough to keep it effective I find this very positive."
"On a general level, I find this positive, however, I unfortunately don't know the actors/ mechanisms well enough to comment on this."

Figure 34. QSR company quotes (Miska Kaskinen, 2024).

4.1.4. Case 4: Logistics company

The third case company of this research paper is a key logistics service provider within the Finnish industrial ecosystem, which offers distinctive lenses to understand logistics operations involved in advancing circular economy practices. This logistics service provider is a current partner of the manufacturing case company and is enabling the scaling of operations through warehousing- and logistics services. Thus, it can provide critical information from the perspective of a key stakeholder in this specific context.

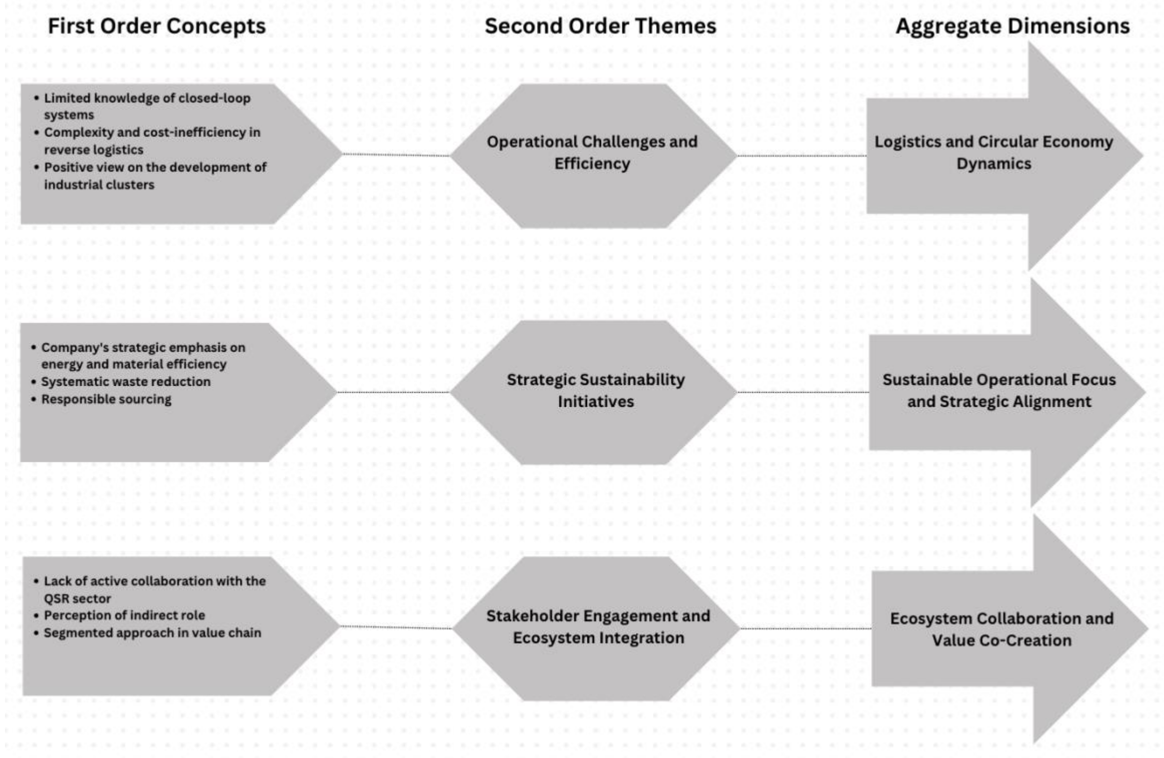

Figure 35. Logistics company case study data structure (Miska Kaskinen, 2024)

Operational challenges and efficiency

The findings uncovered that the logistics provider has very limited knowledge to discuss the development of a closed-loop system for a QSR sector centered around the use of biocomposite material. In other words, the logistics provider does not consider their company to be involved in a way that would provide them with insights into these operations on the challenges involved.

However, the director did highlight the complexity of reverse logistics for low-density products such as biocomposite cutlery which are difficult to handle in a cost-efficient manner. Thus, it can be a significant barrier to the development of a closed-loop system to achieve reasonable scale to make the process cost-efficient and profitable.

Nevertheless, the director also states that the further development of industrial clusters can be a positive process to advance sustainable and economically feasible value chains. This correlates with the findings that the process of building closed-loop systems that are economically feasible requires multi-dimensional cooperation to achieve mutual value co-creation between stakeholders.

Strategic sustainability initiatives

When considering the overall commitment towards sustainable development, it is clear that this has an essential role in the overarching strategy of the logistics provider based on the survey data. The director highlights the emphasis that has been placed on improving energy and material efficiency together with systematic waste reduction, and responsible sourcing programs.

However, looking at the sustainable development and advancement of circular economy from a research-specific context such as the QSR sector, it is evident that there is no direct correlation between these two stakeholders actively collaborating. Furthermore, it would appear that the circular economy initiatives implemented by the logistics provider are more closely aligned with an internal approach towards sustainability rather than leveraging potential external ecosystem engagement which is one of the core principles of industrial symbiosis.

Therefore, it is important to find avenues for improving the external ecosystem level engagement, since this was also supported by the director himself, but it could be that without a clear system and value proposition, it is difficult to find common ground between all relevant stakeholders.

Stakeholder engagement and ecosystem integration

The survey findings revealed that the perception of the director from the logistics provider may not be as well aligned with the other case study companies which highlighted the importance of logistics for circular economy. In other words, the director stated their role to be more peripheral as a warehouse service provider with no direct interaction with end customers in the QSR sector.

Thus it was highlighted that they also do not see any specific need for a more active collaboration between stakeholders in the QSR sector to promote circular economy.

The findings here point to a segmented approach in the value chain, which impacts the effectiveness of circular economy initiatives. There can be several reasons affecting the challenge that is being highlighted here. For example, this could be related to the vague and partly undefined definition of the concept of circular economy which may impact how different stakeholders see circular economy initiatives or what type of inputs can be considered relevant.

In essence, the logistics provider may consider the service it offers through different lenses than the forest industry operator, manufacturer, or QSR operator. For these stakeholders, the logistics service provider can constitute a critical component and enabler for achieving the circulation, collection and storing of products and materials in a cost-efficient way that makes it possible to develop a closed-loop system. Therefore, it could be argued that the importance of cross-functional communication within an external ecosystem environment is critical for developing a further understanding of the value co-creation. That is to say, the total value accumulated through certain services, resources, or mechanisms of collaboration can be difficult to detect without understanding the challenges and possibilities through different lenses.

4.2. Cross-case analysis

The conducted cross-case analysis examines the inter-connected relations between the forest industry, manufacturer, QSR sector, and logistics sector concerning the implementation of circular economy principles and the lifecycle of reusable biocomposite cutlery. This analysis is underpinned by a synthesis of the findings with the existing literature on circular economy, stakeholder engagement, sustainable business models, and value co-creation. The shift towards a circular economy within the QSR sector, exemplified by the adoption of biocomposite cutleries, necessitates a cross-case analysis that bridges the gap between theory and practice. This analysis will draw upon sustainable value co-creation, service-dominant (S-D) logic, viable systems approach (VSA), ecosystem theory, and industrial symbiosis to provide a nuanced understanding of the ecosystem's readiness for circular integration and the collaborative efforts required for a successful transition.

4.2.1. Circular economy implementation challenges

Analysis of multiple case companies within a single case study focusing on a value co creation of an industrial cluster provide unique lenses for understanding the product lifecycle from multiple perspectives. The forest industry case company provides insights into creating a closed-loop system. Emphasizing the importance of the material supplier's role in the product lifecycle and highlighting challenges such as stakeholder engagement, economic scalability, and legislative barriers. The manufacturer case delves into product innovation and quality assurance, touching on consumer engagement for sustainability. The QSR-sector analysis offers a customer-centric perspective on the adoption of reusable cutlery, while the logistics sector case sheds light on the infrastructural challenges in creating efficient recycling systems.

Stakeholder engagement

Across the case companies, stakeholder engagement emerges as a critical factor in implementing circular economy practices, reflecting Vargo & Lusch's (2008) advocacy for multi-stakeholder engagement in sustainable innovation. The forest industry's advancement in circular economy practices highlights proactive efforts, while the manufacturer's collaboration with partners for product development resonates with the principles of value co-creation within industrial ecosystems (Korhonen, 2000; Ayres & Ayres, 1996).

Economic and legislative challenges

The findings from the forest industry and manufacturer cases underline economic challenges, such as the cost competitiveness of biocomposite materials and the financial feasibility of closed-loop systems. These challenges are highlighted in the literature by Kirchherr et al. (2017), who identify market acceptance and regulatory standards as significant barriers to circular economy implementation. Additionally, the need for systemic change, as suggested by Geissdoerfer et al. (2017), is exemplified in the case studies, where both market forces and legislative actions are pivotal in facilitating the transition to circularity.

Logistical and infrastructural barriers

The logistical challenges discussed in the logistics sector case reveal operational barriers in handling low-value density products. This challenge is directly linked to the literature on industrial ecology and the necessity for integrated roles and responsibilities to facilitate value co-creation (Lacoste, 2016). The literature suggests that overcoming these barriers requires a unified approach and cooperative efforts across all stakeholders (Korhonen et al., 2018), which is a sentiment mirrored in the challenges faced by the logistics provider for example.

Summary

The cross-case analysis demonstrates that while technological innovations have progressed, economic and legislative challenges continue to impede the widespread adoption of circular economy principles. The need for standardized processes, both in recycling practices and stakeholder engagement, is imperative. The literature supports the necessity for a systemic approach that includes incentives and regulatory frameworks to support sustainable transitions, while the case study highlight the importance of practical actions and collaborations. Overall, the analysis reveals a complex interplay of factors that influence the transition to a circular economy, calling for a multifaceted approach involving innovation, collaboration, and systemic change.

In summary, the cross-case analysis, coupled with the literature review, provides a nuanced understanding of the transition to circular economy practices within different sectors. It underscores the importance of stakeholder engagement, the impact of economic and legislative challenges, and the critical nature of addressing logistical and infrastructural barriers to facilitate sustainable business models. This comprehensive analysis not only aligns with the theoretical frameworks but also contributes practical insights into the operationalization of circular economy principles

4.2.2. Product Development and Innovation

The case studies consistently underscore the importance of product development and innovation for a circular economy within the QSR sector. In the forest industry, the initial idea to create a drop-in solution and the evolution towards better product ranges using advanced injection molding technology mark significant strides in aligning product offerings with circular economy goals. This pattern can be linked to the research by Nenonen & Storbacka (2010) and Lacoste (2016), which posits the transition from goods-dominant logic to a more service-dominant logic where innovation is not just a supplier-customer dyad but a broader multi-stakeholder engagement process. Additionally, the focus on product durability and surface quality reflects the principles of sustainable production and the need for materials that can withstand the circularity required for a sustainable business model, resonating with the works of Prahalad (2004) and Vargo & Lusch (2008b).

4.2.3. Stakeholder integration and resource management

The case studies, in light of the S-D logic and VSA (Polese, 2017), reveal a systemic need for integration and collaborative dynamics. The innovative material and product designed through the cooperation of forest industry case company and the manufacturer, QSR restaurants operational adaptation, and the logistical coordination by the logistics company, collectively highlight an ecosystem striving for circularity yet confronted with siloed efforts and integration challenges. These stakeholder dynamics necessitate a multi-faceted approach to ensure the seamless flow of materials and information across the ecosystem's actors (Vargo & Lusch, 2016).

The findings from different case companies highlight stakeholder integration and resource management as pivotal aspect for the successful implementation of circular economy practices. The need for a network leader and collaborative initiatives, as mentioned by the manufacturer, is critical in this context. This is aligned with the literature emphasizing the role of stakeholder collaboration in overcoming barriers to circular economy adoption, as supported by Vargo & Lusch (2008) and Korhonen et al. (2018). The complexity of stakeholder engagement and the requirement of customer involvement also align with the service-dominant logic and the ecosystem approach to value co-creation, where every actor is an integral part of the value network (Arnould, 2008; Lacoste, 2016).

Drawing from the sustainable value co-creation research framework (Lacoste, 2016) and the insights on business model configuration (Saarijärvi, 2012; Nenonen & Storbacka, 2010), it is evident that the effective implementation of circular practices is influenced by the congruence of business models across the network actors. The alignment of internal business model elements with the external network configurations emerges as a critical factor for seamless value co-creation within the ecosystem.

4.2.4. Market adaptation and innovation

Across the case studies, the call for standardization and regulatory support is highlighted. The need for standardized practices and regulatory frameworks aligns with the literature that represents these as catalysts for fostering a cohesive environment conducive to sustainable practices (Kirchherr et al., 2017). The synthesis of these findings underscores the importance of a regulatory backdrop that both guides and incentivizes the ecosystem actors toward a unified approach to circularity.

Market adaptation and the need for customer education emerge as crucial aspects of the transition to sustainable practices. The emphasis on innovative packaging solutions and consumer engagement strategies points to a broader market transformation where the success of circular economy practices relies on customer participation and behavior change. This mirrors the assertions made by Lahti et al. (2018) regarding the importance of public awareness and experimental approaches for a sustainable transition and the need for regulatory support as advocated by Kirchherr et al. (2017).

The analysis consistently points to the pivotal role of technological advancements and infrastructural development, as advocated in the industrial symbiosis literature (Baldasarre et al. 2019). The case study indicates a need for investments in technology and infrastructure that cater to the unique challenges of circulating biocomposite materials, from production to recycling and re-utilization to achieve economies of scale.

4.3. Summary of the key findings and the revised framework

The synthesis of identified themes and patterns together with the existing literature underscores the multifaceted challenges and the innovation needed at various levels to support closed-loop systems within the QSR sector. The necessary actions to embed circular economy into the QSR sector at scale range from sustainable product design to stakeholder collaboration. In other words, commitment to product quality, proactive approach to stakeholder engagement, and targeted focus towards market education are instrumental in fostering a circular economy. These findings correlate with the existing theoretical frameworks on value co-creation within industrial clusters, supporting the hypothesis that industrial symbiosis and the interplay of actors are crucial for the sustainable development of closed-loop systems (Baldassarre et al., 2019).

The findings of this cross-case analysis provide a foundation for building an in-depth blueprint for the QSR sector to transition toward the establishment of closed-loop systems. The blueprint can be used to effectively articulate a comprehensive strategy towards incorporating systemic integration, collaborative standardization, and infrastructural and technological advancements within the QSR sector. Thus, confirming the assumptions outlined in the literature review.

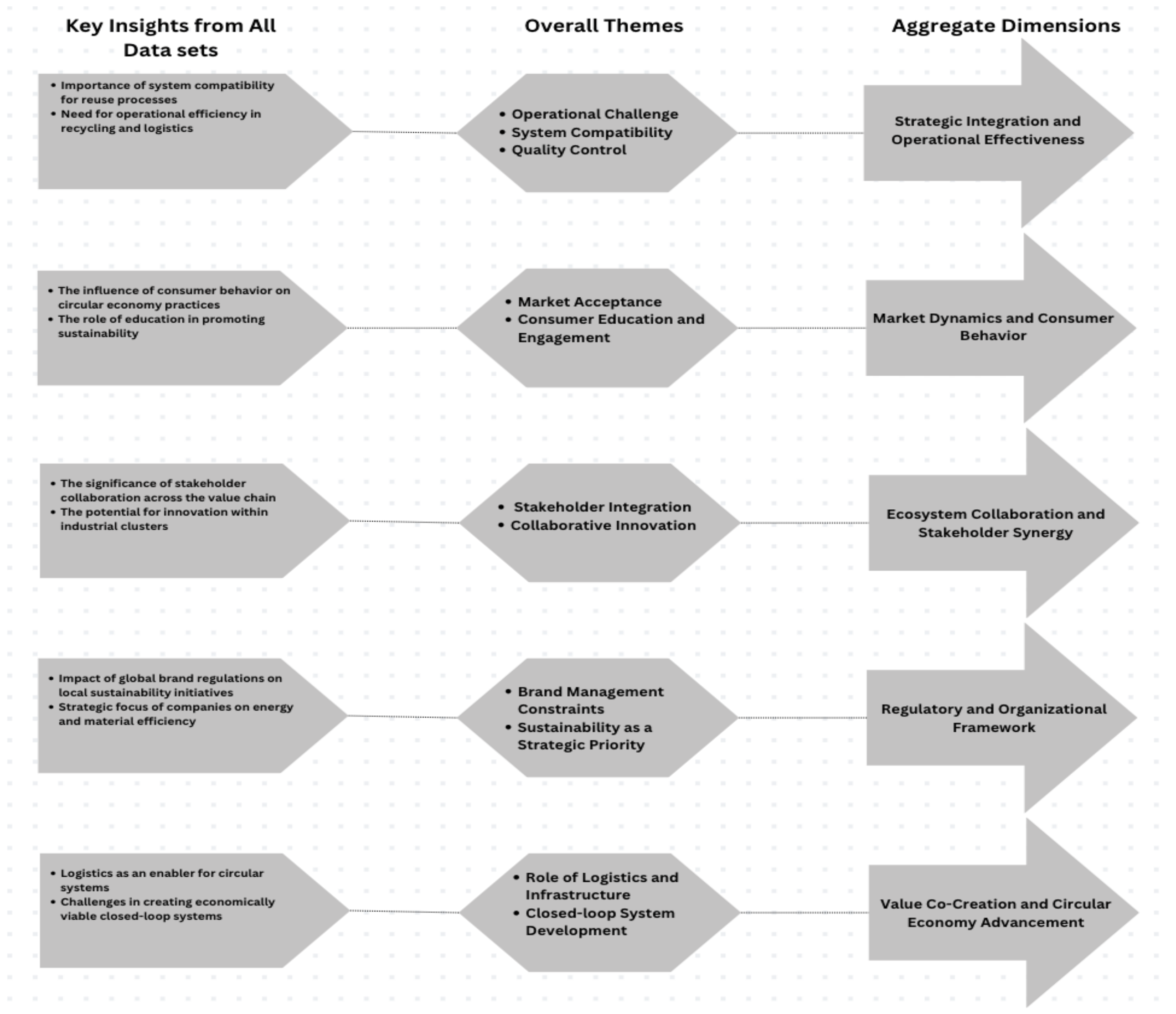

Figure 36. Synthesis of key insights and patterns (Miska Kaskinen, 2024)

This synthesis not only contributes to the existing body of knowledge but also offers a practical and strategic guide for stakeholders within the QSR sector to implement circular economy practices effectively.

4.3.1 Strategic closed loop blueprint

This blueprint summarizes the key resources and mechanisms of collaboration needed for the effective development of the closed-loop system for reusable biocomposite cutlery within the QSR sector as identified through the research. The purpose of this blueprint is to provide a comprehensive answer to the research questions and guide the development of a closed-loop system within the QSR sector by outlining the clear steps to achieve this goal through the findings of multiple case study research.

Collaborative ecosystem approach

The first step is a coordinated ecosystem approach, which aligns all ecosystem actors, leveraging collaborative platforms and shared value-creation principles (Vargo & Lusch, 2016). Based on the literature review and the findings of empirical research, the importance of a coordinated ecosystem approach can only be confirmed. The existing literature adamantly supports the concept of industrial symbiosis and ecosystem theories (Baldasarre et al., 2019) as the source of truth for developing closed-loop systems and circular economy. Similarly, the empirical findings from different case studies either specifically highlight the need for open dialogue between key stakeholders to make jointly agreed ventures possible or the very lack of current resources and collaboration mechanisms suggest that this type of model is needed to develop the internal capabilities of the case companies.

However, the key barrier to the development of said collaboration between stakeholder networks is the economic feasibility of the system. In other words, when considering building new improved business operations over the concept of sustainable systems, it is a definite prerequisite that the system should be able to provide economic benefits to the participants in addition to the environmental benefits. Currently, the most significant challenge for developing closed-loop systems is the overall profitability of the system as a whole which makes it unfeasible for operators to commit. The interview with a representative of the forest industry company highlighted the importance of shifting the perspective from individual products or services towards long-term system-level thinking. This point holds significant value for this research as it represents the fundamental requirement that is needed to develop circular business models and closed-loop systems.

Essentially, it would be necessary to map out the entire system and the processes between different stakeholders to calculate the level of impact this closed-loop system could have on the individual stakeholders but also on the system level as a whole to provide economic and environmental benefits far exceeding the costs. The only way to achieve this level of understanding will require extensive cooperation between different stakeholders to understand their processes, capabilities, and limitations, but also to ensure that the entire system can be built. The coordination of such a venture requires a leading operator, which means that an individual stakeholder with a central role and connections within the network would actively spearhead this project. In the context of the QSR sector and reusable biocomposite cutlery, the manufacturer of the cutlery holds a central role within the ecosystem, which correlates with the requirements of the leading operator for the development of the closed-loop system. We argue that the successful development of a closed-loop system within the QSR sector for biocomposite cutlery must be enabled by the active role of the manufacturer to promote systems-level thinking to connect key industry operators to pursue mutually beneficial economic and environmental gains. Alternatively, the biocomposite material would require applications with higher importance which would make the biocomposite more valuable as a raw material to be fed back to the system, and including the cutlery in the system could be easier at this point. Nevertheless, there must be a stakeholder that manufactures biocomposite products or packaging solutions for the QSR sector and they take the responsibility for spearheading the project.

Regulatory and standardization frameworks hold a key role in the future development of circular economy initiatives. That is to say, the most easily scalable solution for the development of a closed-loop system is building industry-wide standards supported by regulatory frameworks that provide clarity and incentivize sustainable practices (Kirchherr et al., 2017). It is apparent from the research findings that individual stakeholders find it difficult to initiate disruptive changes to the existing systems even though there might be wide acceptance within the ecosystem for new innovations.

This type of findings could also indicate that without further action from the government level, the risk associated with going against the mainstream alternatives in terms of developing material loops can be too high. In other words, without a high level of understanding it could be difficult to know which type of innovative material solution will become a mainstream alternative in the future with great combability to the recycling infrastructure. Thus, investing in the development of new closed-loop systems could be considered unfeasible from individual stakeholders' perspectives unless there is a clear long-term incentive to pursue this type of collaboration. Therefore, it could be argued that the role of government regulations and legislation is very crucial not only for the enforcement of new systems and procedures but also for incentivizing and encouraging the development of new systems by lowering the barriers and risks associated with these new ventures.

Technological and infrastructure investments

Commitment to technological innovation and infrastructure development can be considered a key aspect of the development of a circular economy and closed-loop systems as informed by the principles of industrial symbiosis (Baldasarre et al. 2019). Despite the fact, that there have been conflicting opinions on the importance of technology for the development of closed-loop systems both in the existing research in academia, but also within the empirical findings.

That is to say, both the existing research (Kirchherr et al. 2018) and empirical findings point out that technological barriers are the least pressing ones for the development of circular economy initiatives and closed-loop systems. This can be directly linked to the fact that the prerequisites to build fully operational closed-loop systems are already available with no technological limitations impacting this equation. In contrast, the most pressing barrier can be identified as the involvement of stakeholders to participate within the ecosystem.

Nevertheless, to develop a fully functional closed-loop system for biocomposite cutlery or any other products made from biocomposite, it is essential to invest in the product development, production capacity, collection and re-use systems, and re-alignment of current recycling infrastructure from fossil-based plastics to support the use of sustainable raw materials. In other words, the empirical findings suggest that no extensive new innovative technology is needed to achieve the benefits of the closed-loop system but investments are needed to build the system for scalability and volume. This can be considered a fundamental prerequisite for achieving the scale necessary for effective recycling and implementation of reusable biocomposite cutlery.

Educational initiatives and stakeholder engagement

Referring to the research of Lacoste (2016) and Giarini (2000), programs aimed at educating and engaging stakeholders, ensuring their active participation in the circular economy can be considered fundamental steps in the development of a closed-loop system. That is to say, the research of Lacoste (2016) and Giarini (2000) acknowledged the fact that S-D logic could be applied to the physical products as different stages or product lifecycles. The idea of creating an interactive network between customers and suppliers as the basis of a sustainable product is supported by the empirical findings of this research. The successful implementation of a closed-loop system to develop, reuse, and recycle biocomposite cutlery is entirely dependent on the customer network taking an active role within the system to enable the functional collection and recycling system (Simula et al. 2009).

However, the actual implementation of collaborative initiatives between customer networks and supplier networks can be challenging in practice. The specific activities that could be implemented to support stakeholder education such as educational materials, employee training, and marketing initiatives are effectively outlined in this research but fail to explain all the applicable views of this topic. That is to say, this equation cannot be considered as a simple issue of launching certain activities to educate stakeholders to promote the desired change within the market. Instead, it is necessary to consider all the different elements that may impact why certain stakeholders are not actively supporting the change within the market. In other words, although the EU Commission has taken actionable steps to change regulations to support the use of reusables within the QSR sector, the timeline for enforced implementations is still long. This means that both QSR operators, as well as consumers, might be subjected to refrain from participating in this new ecosystem if it disrupts their current norms, processes, or economic profitability.

Essentially, this only highlights the need for leading operators which has been a dominant theme throughout the empirical research. In other words, this type of disruptive change within the market requires fundamental change away from traditional operative models to focus on systems-level thinking. Without a leading operator to educate and persuade the stakeholder network on the potential system-wide benefits, it can be difficult to coordinate and drive change. Korhonen (2018) highlighted an important question that should be taken into consideration when developing the closed-loop system for reusable biocomposite cutlery; *" Who is the leader in the network, who bears the biggest responsibility, who gains the most from the network operation, who loses the most if the project is unsuccessful or faces the biggest risks, what is the overall budget of the network, who controls it and which actors contribute to it, what is the network decision-making platform, who organizes it".* These questions should be used to gauge the overall dynamics of the ecosystem and how the business models of each stakeholder should be aligned to mitigate individual risks but also create mutual value propositions for all parties involved. Whether a small startup such as the manufacturing case company can have the required impact on the market as a leading operator or if this would require more powerful market players' involvement is a critical question to answer when considering the long-term development of a closed-loop system for reusable biocomposite cutlery.

Summary

In conclusion, the empirical findings together with the existing research conducted on the subject, clearly support the overall hypothesis of this research paper by demonstrating the extensive need for resource deployment and alignment together with collaborative mechanisms. Furthermore, the developed blueprint provide a clear pathway towards the implementation of a closed-loop system for QSR within applications where biocomposite could be utilized as a raw material.

The final picture effectively summarizes the visual representation of this closed-loop system and the interdependencies between different stakeholders within the ecosystem. Thus, allowing the key resource and collaborative efforts to be mapped throughout the product lifecycle and different stages of value co-creation.

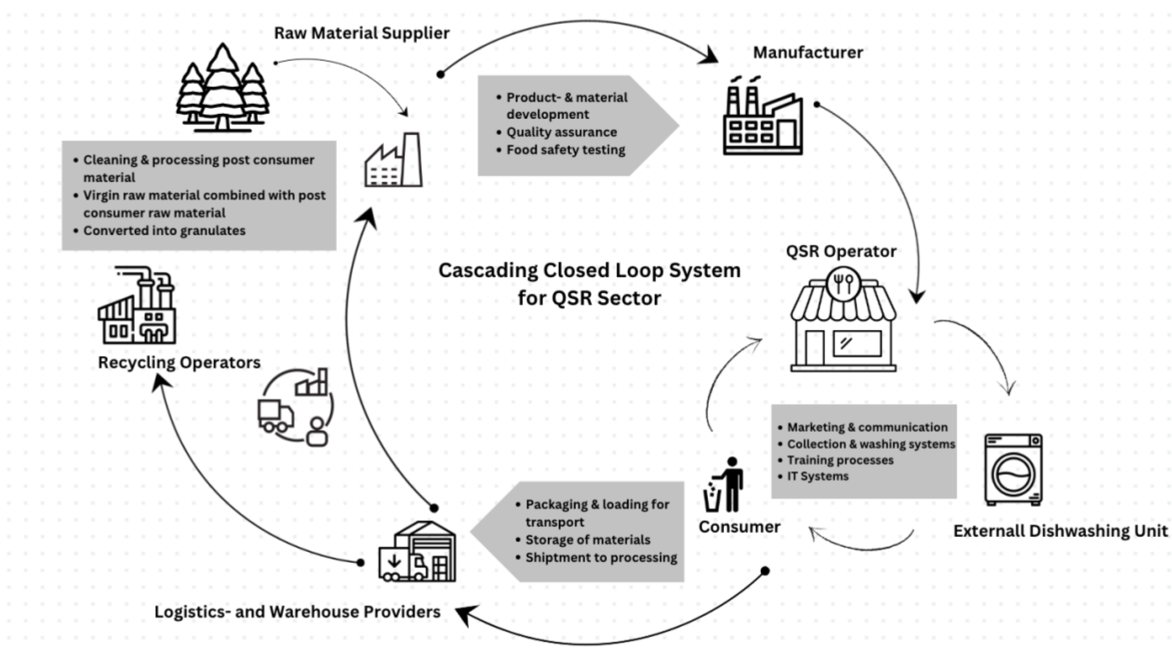

Figure 37. Cascading closed loop system for QSR sector (Miska Kaskinen, 2024).

5. DISCUSSION

5.1. Theoretical implications

This research paper provide a meaningful contribution towards filling the research gaps identified in the existing literature by providing detailed insights from a system that is currently using waste streams to build new products (Korhonen, 2000; Ayres & Ayres, 1996; Baldasarre et al. 2019; Frosch & Gallopoulos, 1989). Furthermore, the research paper tries to close the loop by addressing the gaps in research that explain the identification of resources and incentivicement of network collaboration (Nenonen & Storbacka (2010). Thus, offering a robust framework for academia and policy-making to build on the developed theories through an increased understanding on the research-specific context of QSR sector and building closed-loop systems for sustainable materials. Despite the different stakeholder perspectives studied within this research paper, it is inconclusive how deeper collaboration could be incentivized even though all the required resources are readily available. This supports the findings of the existing literature highlighting the complexity of applying circular economy practices in a multi-stakeholder environment (Lacoste, 2016).

5.1.1. Stakeholder engagement and value co-creation

Based on the empirical findings of this research paper, it is clear that more extensive research is needed on the dynamics of stakeholder collaboration in circular economy practices. The empirical findings have effectively highlighted the complexities of the stakeholder network within the QSR sector to develop an operational closed-loop system. The identified need for customer engagement and education in sustainability initiatives aligns with the service-dominant logic and sustainable value co-creation principles discussed in the research paper (Vargo and Lusch, 2008b; Saarijärvi, 2012). Furthermore, the case study successfully underscores the importance of stakeholder collaboration and leadership in driving the success of circular economy practices, which is a key theme in the exploration of industrial clusters and value co-creation

(Lacoste, 2016). These findings provide an overall direction for the development of stakeholder networks.

However, despite the case study successfully underscoring the key themes of the existing literature, the author underpins the notion that further case-specific research is needed on the development of stakeholder relationships. For example, the data gathered from the logistics company highlights the importance of integrated roles and responsibilities between stakeholders to facilitate value co-creation. The limited direct interaction with stakeholders by the logistics company and lack of perceived need for such interaction, suggest that the network currently lack unified approach (Korhonen et al., 2018). Similarly, the findings from QSR restaurant chain highlighted lack active interaction with stakeholders in the context of circular economy, but it was still acknowledged as an important area of improvement. It could be argued that in many cases the companies producing innovations take more active role to advance collaboration within stakeholder network, but unless new concept is accepted by key actors within the ecosystem, it is difficult to implement deeper level of collaboration (Lahti et al., 2018).

An extensive amount of data highlights the role of consumers at the center of circular economy as enablers for new business models. This is explicitly building on the research of Kirchherr et al. (2017) who suggested further studies on the role of consumer within circular economy. When considering the role of a consumer in using reusable cutlery during their service experience with a QSR restaurant, the influence is significantly lower since everything is already operating within a system managed by the restaurant. However, when the use of reusable cutlery is extended beyond the immediate proximity of the restaurant, then the burden of ensuring proper collection, washing or recycling is passed on to the consumer (Korhonen et al. 2018). The underlying cause behind consumer decision to participate in the closed-loop system could be connected to several different variables. These variables can range from negatively perceived extra effort to limited understanding of the collection instructions or the environmental impact of not recycling the materials and ensuring an efficient product lifecycle. It was indeed acknowledged in the forest industry company interview that the standardization for labeling and marking of material- and recycling instructions is one of the most important steps towards improving national-level recycling of any materials.

In contrast, the empirical findings do provide accurate data on the technical deliverability of a closed-loop system for reusable biocomposite cutlery within the QSR sector and operate as a blueprint for practical implementation. Thus, the findings of this research effectively build on the research of Nenonen & Storbacka (2010) for this specific context by identifying the explicit resources needed by the case companies within industrial cluster to establish a closed-loop system. In other words, the interviews with the case companies were able to identify all the major challenges or barriers for the development of the closed-loop system and indicate the required resources and mechanisms of collaborations across the product life-cycle. For example, the manufacturing company has taken a leading role building the recyclability of their products, stakeholder collaboration, and consumer engagement through addressing the key resources needed. This reflects the critical questions raised in the literature regarding the implementation of circular economy practices and the roles of various actors within the network (Korhonen et al., 2018; Nenonen & Storbacka, 2010; Lacoste, 2016).

The research provide an in-depth framework for explaining the value co-creation process within the ecosystem. While the technical elements in the form of resources and specific mechanisms of collaboration have been mapped by this research, it is still unclear how to incentivize stakeholders to contribute to the development of the system. The problem with integrating highly different business models of different organizations comes down to the various social-, economical- and organizational factors that are influencing the environment these businesses operate in (Corvellec et al. 2022; Kirchherr et al. 2017). To create such a framework, more research would be needed on the examination of different roles and interrelations of different actors within the QSR sector, who would be actively contributing to the development of such a system. Furthermore, more research on an active and operational closed-loop system would allow more data to be gathered on the actual resources and collaboration mechanisms that are being utilized already to build an understanding of the value co-creation processes. This type of approach could yield better results for explaining the research of Lacoste (2016) on how these companies could potentially contribute collaboratively to the process of sustainable business model integration.

5.1.2. Ecosystem and Sustainable Lifecycle Configuration

The empirical findings of this research paper provided significant insights into the development of more sustainable ecosystems that are shifting away from fossil-based resources towards the utilization of waste-based renewable resources. The case study is successfully implementing the concepts of industrial ecology and development of industrial clusters that emulate the natural ecosystems from existing literature (Korhonen, 2000; Ayres & Ayres, 1996; Baldasarre et al. 2019; Frosch & Gallopoulos, 1989). The detailed analysis of empirical findings, grounded in the interview data, align with the current literature, particularly in the industrial ecology (IE) and circular economy (CE) research streams. the case offers invaluable insights into the practical application of sustainable manufacturing practices within the context of the circular economy. Illustrating the multifaceted challenges and opportunities inherent in the transition towards more sustainable business practices, providing a practical lens through which to view the theoretical frameworks discussed in the research paper (Korhonen, 2000; Ayres & Ayres, 1996; Baldasarre et al., 2019; Geissdoerfer et al., 2017; MacArthur, 2013).

However, the main concern that raised from the existing literature in relation to the implementation of circular economy initiatives, was the overall impact against the triple bottom line, sustainability, performance of supply chains, business models, innovation systems and economy in general (Geissdoerfer et al., 2017). When considering this topic, it is difficult to provide generalizable models since the application of circular economy initiatives is closely linked with regional implementation and changing routine behavior and economic activity as acknowledged by Korhonen (2000). For this specific case context, the empirical findings provide strong evidence for the feasibility of this industrial cluster to support improved level of sustainability and economic growth. It was specifically highlighted by interviewee from the forest industry company that by achieving the necessary scale it is possible to achieve long term benefits at the system level when using renewable alternatives that outweigh the current economic models. Thus, the main barrier for developing circular business models, based on the concept of sustainable cradle to grave product lifecycle, can be related to the challenges to disrupt the currently established systems without the needed economies of scale (Kirchherr et al. 2018; Corvellec et al. 2022).

Therefore, this research paper is able to successfully build on the research gap presented by Geissdoerfer et al. (2017), indicating that better understanding of the relationship between the Circular Economy and sustainability is needed. Essentially, Geissdoerfer (2017) suggested that it could not be guaranteed that business models based on the concept of circular economy would necessary have positive influence over the performance of supply chains, business models, and innovation systems. While this statement is arguably correct, the empirical findings highlight the importance of available resources and alignment across the value chain to support the utilization of circular solutions. The findings could be generalized to some extent for analysing various industries and the capabilities to configure more sustainable business models that supports the sustainable lifecycle of products and services from cradle to grave. In theory, by successfully aligning with the existing resources of the ecosystem and business model configurations of the value chain, a network actors within an industrial cluster can create a sustainable competitive advantage that is based on the supra-level of value that is created through cooperation. The transition towards circular economy models provides a unique opportunity for companies and even countries to redefine the concept of competitive advantage. The theoretical implications of this disruptive change are closely related to the revised understanding of sustainability and how this can be leveraged for long-term profitability and market differentiation. To further increase the level of understanding, research, and academia should focus on addressing system-level changes within industrial clusters to drive circular solutions.

5.2. Managerial implications

The managerial implications of this research expand significantly further from the theoretical implications due to the practical nature of the research to understand the resources and mechanisms needed to drive change. The research can create a roadmap toward the practical implementation of a closed-loop system within the QSR sector by highlighting the capabilities, limitations, and existing perceptions of various stakeholders to assess the conditions to start building an industrial cluster. This research paper provide managers with strategic tools and perspectives to start implementing inter-organizational collaboration and orchestrate coordination across the product lifecycle, fostering a coherent approach to product and service offerings within the QSR sector. The insights gathered from the case study underscore the importance of integrating circular economy principles into the core business model, which can be particularly challenging in a complex and multi-layered industry such as QSR sector. Managers can draw on these insights to analyze their current business models, reassess market configurations, and identify opportunities for integration that not only enhance the value proposition for all involved stakeholders but also contribute to broader sustainability goals.

5.2.1. Stakeholder engagement and collaboration

Stakeholder engagement and collaboration are at the center of this research topic to enable the development of a closed-loop system for reusable biocomposite cutlery within the QSR sector. While it has been established that the successful development of a closed-loop system does require a leading operator due to the extensive nature of the project, it is also mandatory for directors and managers to start actively considering avenues for contributing to this type of system. This is essential for recognizing the interdependence between each actor and actively building on the existing capabilities to accommodate the integration of resources.

When considering the situation from a practical perspective, it is very difficult to drive change if you are not actively interacting with each actor within the system and hold a central role within the ecosystem. For example, if the manufacturer of reusable cutlery assumes the role of a leading operator, challenges could arise with relatively weak market power without strong support from key actors and relevant relationships with all the different stakeholders along the value chain. In this regard, the QSR restaurant chain could be considered as the preferred leading operator since they hold the central role within the ecosystem that builds the foundation for adapting the individual stakeholders into to the requirements of the QSR restaurants business model. This establishes the prerequisites to start considering the total lifecycle of different materials and products while aligning value chains to start accommodating circular design. However, it should be noted, that the hypothesis here assumes that the QSR restaurant is a company with a significant market power and potentially even global presence. The main challenge or barrier could be considered as the lack of communication between the various decision-makers within these companies and creating a platform or forum that acts as a collaborative network could be an effective catalyst to drive change.

In essence, by analyzing both existing literature and empirical findings it could be assumed that it is very difficult for actors such as the forest industry company or manufacturer to drive change within the marketplace without the lead of a high-profile QSR restaurant. When considering the implications of this for the development of a closed-loop system within the Finnish ecosystem, the change will certainly occur in the future since it is already enforced by the EU regulations to switch to the use of reusable alternatives and at this point. The main challenges and constraints associated with the setup of a closed loop system can be solved by achieving the needed economies of scale. That being said, the resources needed to generate value are already existing and the fundamental question is the timeline for change and whether the QSR sector is incentivized to start actively collaborating with other stakeholders before mandatory enforcement by the EU Commission. In essence, learning how these different business models can be aligned to create a cohesive strategy for addressing the requirements of a circular economy is a critical skill for future managers. The fundamental step here is to transition from a perspective that only considers initial investment, costs, or face value of a product towards a long-term system-level thinking that can be the basis for greater ecosystem level sustainable competitive advantage.

5.2.2. Investment in technology and innovation

Investments in technology and innovation have a critical role in the development of a closed-loop system for reusable biocomposite cutlery since the successful utilization of the cutlery requires investing in product innovation, quality assurance processes, and recycling technologies that enhance the lifecycle of products and materials. However, it is important to distinguish that the word innovation should be used with care since there is no explicit innovation required at a larger scale but rather minor developments to improve overall systems and processes. The overarching investments are focused on the re-configuration of existing systems to accommodate the circulation of reusable biocomposite cutlery and then scale this system for wider use.

The economic feasibility of different systems and investments must be considered by the management. The overarching business models should not only focus on sustainability but also ensure economic viability and scalability. It is essential to analyze the total cost of ownership, considering long-term benefits over immediate costs, and exploring economies of scale when deciding the vehicles for setting up the industrial clusters to support circular economy.

The challenges and barriers related to the adequate understanding of system-level viability, cost structure, and scalability can be directly linked to the lack of cooperation between network operators. This builds on the previous section as the active collaboration and shared view to integrate business models could alleviate the challenges for understanding system-wide benefits and risks of certain investments or innovative changes.

5.2.3. Consumer engagement and education

Educating consumers about sustainable practices and the benefits of participating in a circular economy is essential. The successful implementation of reusable cutlery within the QSR sector would require managers to implement strategies to influence consumer behavior. These strategies include clear communication on product usage and disposal, and programs that incentivize the return and recycling of cutlery.

However, the other aspect of developing a closed-loop system is the effective recycling of the raw materials when operating outside the QSR restaurant such as in takeaway. This requires national standardization of labeling and collection systems to equip consumers with the capabilities to effectively participate within the system.

In essence, transitioning to circular business models and utilization of reusable products made from biocomposite material within a closed-loop system requires consumer buy-in. Both managers of the QSR sector and government authorities together with recycling operators must encourage consumers to participate actively in the circular system while enabling the practical implementation.

5.2.4. Policy and regulatory alignment

This research paper is built on the advancement of strict regulations and legislations governing the operations of the QSR sector such as Single-Use Plastic Directive (SUP) and Packaging- and Packaging Waste Directive (PPWR). These regulative changes are effectively enforcing the use of reusable alternatives within restaurants in the near future. This research paper advocates managers to prepare their operations to be agile and adaptable to comply with these changes, which may require investment in new processes or technologies.

The findings implicate that the most successful QSR restaurants within this disruptive market landscape are able to align their business strategies with policy frameworks to simultaneously support sustainable development and create a competitive advantage through integrated ecosystem collaboration. However, it should also be noted that the regulative- and legislative changes open possibilities for wider discussions across industries to influence policy development and supporting initiatives to drive the development of circular systems within the entire ecosystem.

Essentially, the regulative environment acts as the catalyst for the overarching market change and the effects cascade across to the other areas. Thus, the managerial implications of this research paper can be summarized as a need for a strategic, integrated approach to sustainability, where collaboration, investments, and consumer engagement are at the core of managerial actions. Managers are encouraged to consider these implications as a roadmap to navigate the complex landscape of sustainable development within their respective industries.

5.3. Limitations and suggestions for future research

The limitations of this research are multifaceted and acknowledge the constraints of the methodological choices, case study selection, and overall scope of research. While the insights derived from the case studies are robust and offer a valuable contribution towards developing a closed-loop system within the QSR sector, certain limitations should be considered.

There was variance in the primary data collection method since conducting live interviews for all case companies was not possible due to the limited availability of key personnel. While the email responses provided in-depth insights, they lacked the dynamism and elaboration that face-to-face interactions facilitate. This may have impacted the depth and nuance of the findings, potentially limiting the exploration of certain aspects of the closed-loop system within the QSR sector. Moreover, the reliance on self-reported data from participants poses a threat to internal validity, since there is a possibility that responses could be biased or influenced by company policies or personal beliefs about sustainability and circular economy practices.

When considering the wider implementation of closed-loop systems, research focus on the QSR sector and reusable biocomposite cutlery, may not capture the entirety of the challenges and opportunities present in the development of closed-loop systems for different sectors. Thus, this research stream may benefit from a broader examination of closed-loop systems across different types of service industries since the generalization of the findings is limited by the specificity of the case study. The conclusions drawn from the research findings relating to the development of closed-loop systems may not be directly transferable to other sectors or geographical areas without additional research. Therefore, the insights may not be universally applicable across different contexts or geographies, and extrapolation of the results should be done with caution. It should also be taken into consideration that the selection of case companies, while strategically chosen for their relevance and contribution to the research objectives, may not encompass every step of the value chain within the QSR sector. That is to say, the lack of primary research with recycling operators, different logistics providers, and end consumers may affect the comprehensive picture generated on this topic.

In addition, this research paper highlights the critical influence of consumer behavior and regulatory frameworks for the development of closed loop systems, but it does not cover these topics in depth. For example, consumer behavior is a critical determinant in the successful implementation of closed loop systems, yet this research does not delve deeply into the psychological and social factors that influence consumer choices and behaviors. This is a key topic to research to develop a better understanding of the psychological and social factors that play a role in the consumer acceptance of change. In relation, while the research acknowledges the important role of regulation, it does not extensively explore the potential for regulatory frameworks to evolve and shape the future of closed-loop systems in the QSR sector. The regulative environment can significantly influence every stakeholders decision-making process relating to the closed-loop systems but also enable or restrict them in general. Due to the correlative effect that regulation can also have on consumer behavior, it is critical to understand both of these concepts and how these interrelate. Further research on the interrelations of these topics can provide value for policymakers and support the development of regulative frameworks that favorable conditions in terms of psychological and social conditions.

The limitations of this research open pathways for future research opportunities to build upon the findings of this study, exploring new dimensions and applying the insights to broader contexts.

It is through acknowledging and addressing these limitations that the field can continue to advance and refine the integration of closed-loop systems into various industrial settings. Based on the comprehensive analysis and findings of this research, future research can build upon the emergent themes and challenges identified in the transition to sustainable practices and the development of a closed-loop system within the QSR sector. Future research should focus on key areas such as extended stakeholder analysis, consumer behavior dynamics, cross-industry learning, global versus local strategies, policy and regulatory impact, longitudinal studies, closed loop system efficiency, and collaborative frameworks and platforms.

Firstly, further research should focus on the extended stakeholder analysis and delve into the roles and interplay of key stakeholders in the circular economy. This should focus particularly on stakeholder motivations, contributions, and resistances within the industrial ecosystem. This research stream could also be considered intertwined with cross-industry learning, where researchers could investigate how circular economy principles are adapted across different sectors. Findings here can provide valuable insights into the transferability of strategies and practices, potentially leading to a cross-pollination of ideas and innovations. To facilitate the needed stakeholder cooperation and engagement on the industrial ecosystem level, a more practical research focus could also be taken to study the use of different platforms or forums to connect and incentivize cooperation between stakeholders. In essence, these areas of future research would serve as the catalyst and enabler for building better models to promote stakeholder cooperation and value co-creation.

The following research areas should focus on the influence of consumer behavior and regulatory changes as well as how these variables should be accommodated into the overarching strategy to create closed loop systems. A substantial amount of research could be conducted on consumer behavioral studies and specifically relating these to the use of reusable alternatives which are disrupting their current behavioral models quite substantially. This area of research could be critical for understanding the psychological and social drivers that influence customer acceptance and long-term adoption of circular economy practices in the QSR sector. Hence, it could be argued that the study of the consumer as an individual stakeholder within the ecosystem generates an intersection where behavioral economics research could provide meaning and further insights on how to adapt to the disruptive changes in existing behavioral norms in the fast food industry. In other words, theories on consumer behavior could be expanded to include the motivators and barriers to consumer engagement in circular systems which would allow reusable packaging and cutlery to be collected and washed at scale. Nevertheless, since the entire sector and related industries are heavily guided by changes in regulation and legislation, further research is needed to evaluate the impact of current and forthcoming regulations on circular economy practices within the QSR sector. This has a fundamental role in understanding how businesses can adapt to and influence policy developments proactively, which could also be potentially adapted to provide considerations for different global markets on how to support the implementation of closed-loop systems.

All in all, the most important area of research in the long term is to understand the overarching implications of circular economy initiatives and the development of closed loop systems. What is the effect on overall sustainability and economic growth on both local- and global markets? Long-term studies that track the implementation and outcomes of circular economy initiatives within the QSR sector can provide empirical evidence of the sustainability and economic impacts of these practices over time. This feeds into a different area of research focusing on the optimization of closed-loop systems for efficiency, including the logistics of collection, cleaning, and redistribution of reusable items in the QSR context. Finally, implementing further research in the form of comparative studies between global QSR chains and local QSR restaurants in their approach to circular economy practices can shed light on scalable strategies and localized adaptations. Potentially, closing the loop for solving the challenges and barriers of circular economy on a global scale.

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APPENDICES

Appendix 1.

QSR-restaurant interview questions:

1. How do you feel about the implementation of reusable cutleries within QSR sector?
    a. How would you compare these to the single-use cutleries?
2. What do you see as the biggest challenges for implementing reusable cutleries within QSR sector?
    a. What type of processes should be developed for effective implementation of reusable cutleries?
3. How are your processes and services being aligned to support the utilization of reusable solutions in the future?
    a. Is there something worth highlighting?
4. Are you actively interacting with key stakeholders to support development of new products or materials to be used in the restaurants?
    a. If not, why?
    b. If yes, what type of interaction?
5. Do you see a need for more active collaboration between stakeholders to support the use of reusables within QSR sector?
    a. If so, what type of collaboration?
    b. If not, why?
6. How important is sustainable development for your company?
    a. Are the any planned actions to support circular economy?
7. How do you see reusable cutleries made from biocomposite material supporting sustainable development and circular economy within QSR sector?
    a. Do you see any barriers for the use of biocomposite materials?

   b. What would be the key benefits?

8. What is your opinion on the development of a closed loop system to reduce overall material consumption and increase resource efficiency?

9. How do you feel about relevant industry actors cooperating to create more sustainable business models and developing industrial clusters to enhance resource sharing and collaboration mechanisms?

10. Do you see development of industrial clusters advancing the closed loop systems for reusable biocomposite cutleries within QSR sector?

11. What are the key partners, resources and mechanisms for collaboration that you see as mandatory to develop a closed loop system for reusable biocomposite cutleries within QSR sector?

    a. How would you develop these?
    b. Can these be attained / developed through the immediate stakeholder network?
    c. If not, how?

1. How the absence of key partners, resources, expertise or technology could affect the development of a closed loop system and effective circulation of reusable biocomposite cutleries?

    a. Can these inhibit the effective development, utilization and recycling of reusable biocomposite cutleries?

    b. Can you provide examples?

2. How your current resources, expertise and technologies could be developed through industrial clusters and network collaboration?

3. What strategies would you implement in the future to support the effective- and sustainable utilization of reusable biocomposite cutleries within QSR sector?

    a. Collaboration
    b. Technology
    c. Processes
    d. Etc.

Appendix 2.

Forest industry interview questions:

1. How does your processes and material development contribute to the utilization of reusable biocomposite cutleries within QSR-sector?
    a. How has these developed over time?
    b. Is there something worth highlighting?
2. Does the food contact application create any limitations or challenges?
3. Are you actively interacting with key stakeholders to support the material development?
    a. If so, who?
4. Do you see a need for more active collaboration between stakeholders to promote the use of biocomposite material in food contact applications?
    a. If so, what type of collaboration?
5. How important is sustainable development for your company?
    a. Are there any planned actions to further support circular economy?
6. How do you see reusable cutleries made from biocomposite material supporting sustainable development and circular economy within QSR sector?
    a. Do you see any barriers for the use of biocomposite materials?
    b. What would be the key benefits?
7. What is your opinion on the development of a closed loop system to reduce overall material consumption and increase resource efficiency?
8. How do you feel about relevant industry actors cooperating to create more sustainable business models and developing industrial clusters to enhance resource sharing and collaboration mechanisms?
9. Do you see development of industrial clusters advancing the closed loop systems for reusable biocomposite cutleries within QSR sector?

10. What are the key partners, resources and mechanisms for collaboration that you see as mandatory to develop a closed loop system for reusable biocomposite cutleries within QSR sector?

    a. How would you develop these?
    b. Can these be attained / developed through the immediate stakeholder network?
    c. If not, how?

11. How the absence of key partners, resources, expertise or technology could affect the development of a closed loop system and effective circulation of reusable biocomposite cutleries?

    a. Can these inhibit the effective development, utilization and recycling of reusable biocomposite cutleries?

    b. Can you provide examples?

12. How your current resources, expertise and technologies could be developed through industrial clusters and network collaboration?

13. What strategies would you implement in the future to support the effective- and sustainable utilization of reusable biocomposite cutleries within QSR sector?

    a. Collaboration
    b. Technology
    c. Processes
    d. Etc.

Appendix 3.

Manufacturer interview questions:

1. How does your product and service development contribute to the utilization of reusable biocomposite cutleries within QSR-sector?

    a. How has these developed over time?
    b. Anything that should be improved?
    c. Is there something worth highlighting?

2. Are you actively interacting with key stakeholders to support the product and service development?

    a. If so, who?

3. Do you see a need for more active collaboration between stakeholders to promote the use of biocomposite material in QSR-sector?

    a. If so, what type of collaboration?

4. How important is sustainable development for your company?

    a. Are there any planned actions to further support circular economy?

5. How do you see reusable cutleries made from biocomposite material supporting sustainable development and circular economy within QSR sector?

    a. Do you see any barriers for the use of biocomposite materials?
    b. What would be the key benefits?

6. What is your opinion on the development of a closed loop system to reduce overall material consumption and increase resource efficiency?

7. How do you feel about relevant industry actors cooperating to create more sustainable business models and developing industrial clusters to enhance resource sharing and collaboration mechanisms?

8. Do you see development of industrial clusters advancing the closed loop systems for reusable biocomposite cutleries within QSR sector?

9. What are the key partners, resources and mechanisms for collaboration that you see as mandatory to develop a closed loop system for reusable biocomposite cutleries within QSR sector?

    a. How would you develop these?
    b. Can these be attained / developed through the immediate stakeholder network?
    c. If not, how?

10. How the absence of key partners, resources, expertise or technology could affect the development of a closed loop system and effective circulation of reusable biocomposite cutleries?

a. Can these inhibit the effective development, utilization and recycling of reusable biocomposite cutleries?

b. Can you provide examples?

11. How your current resources, expertise and technologies could be developed through industrial clusters and network collaboration?

12. What strategies would you implement in the future to support the effective- and sustainable utilization of reusable biocomposite cutleries within QSR sector?

    a. Collaboration
    b. Technology
    c. Processes
    d. Etc

Appendix 4.

Logistics provider interview questions:

Background information

1. How does your service development contribute to the utilization of reusable biocomposite cutleries within QSR-sector from logistics point of view?

    a. How has these developed over time?
    b. Anything that should be improved?
    c. Is there something worth highlighting?

2. Are you actively interacting with key stakeholders to support the circular economy?

    a. If so, who?

3. Do you see a need for more active collaboration between stakeholders to promote the circular economy in QSR-sector?
    a. If so, what type of collaboration?

4. How important is sustainable development for your company?

    a. Are there any planned actions to further support circular economy?

5. How do you see reusable cutleries made from biocomposite material supporting sustainable development and circular economy within QSR sector?

    c. Do you see any barriers for the use of biocomposite materials?
    d. What would be the key benefits?

6. What is your opinion on the development of a closed loop system to reduce overall material consumption and increase resource efficiency?

7. How do you feel about relevant industry actors cooperating to create more sustainable business models and developing industrial clusters to enhance resource sharing and collaboration mechanisms?

8. Do you see development of industrial clusters advancing the closed loop systems for reusable biocomposite cutleries within QSR sector?

9. What are the key partners, resources and mechanisms for collaboration that you see as mandatory to develop a closed loop system for reusable biocomposite cutleries within QSR sector?

    d. How would you develop these?
    e. Can these be attained / developed through the immediate stakeholder network?
    f. If not, how?

10. How the absence of key partners, resources, expertise or technology could affect the development of a closed loop system and effective circulation of reusable biocomposite cutleries?

    c. Can these inhibit the effective development, utilization and recycling of reusable biocomposite cutleries?

    d. Can you provide examples?

11. How your current resources, expertise and technologies could be developed through industrial clusters and network collaboration?

12. What strategies would you implement in the future to support the effective- and sustainable utilization of reusable biocomposite cutleries within QSR sector?

    e. Collaboration
    f. Technology
    g. Processes
    h. Etc.