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Exploring the use of a technology driven procurement strategy in stimulating circular value chains for post-consumer plastic in Norwegian aquaculture

Master's thesis in Global Manufacturing Management
Supervisor: Luitzen de Boer
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Science and Technology

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Abstract

The circular economy (CE) has in recent years been at the forefront in reducing the environmental impact of various industries. This is achieved by closing the loop according to the principles of recovery, recycling, and value retention. However, the widespread introduction into a circular economy requires a stimulus. In this thesis, we will explore how the use of a technologically enabled procurement strategy can stimulate suppliers in the aquaculture industry to provide more circular products and materials. This thesis was written with inspiration from the POCOplast project. By qualitatively examining two actors included in this project, Grieg Seafood and Flokk, the potential of the procurement function to stimulate the circular economy was explored, as well as how technology can further enhance these effects. Grieg Seafood is a major plastics consumer and plastic is a key material for its aquaculture operations. Grieg Seafood aims to stimulate the circular economy by increasing their sourcing of recycled plastics, while also identifying opportunities for their plastic waste to be used in other industries. Flokk is already an established consumer of recycled plastics in the furniture industry and is interested in increasing the supply of post-consumer plastic. A framework was used to link the literature on circular procurement and technology to these qualitative findings to analyse the findings. Procurement's potential in stimulating CE lies in the creation of criteria and specifications that are in line with the organisation's overall CE strategy. This includes both the level of circularity of the products purchased and the business models used. While implementing circular business models it is important to maintain the CE principles of re-use, as well as using circular materials to see a positive environmental impact. With increased circularity, and maturity of the concept, the cost-effectiveness of circular products could increase, while alleviating concerns related to quality and lifetime. Technology, both basic technology like various ICT solutions, as well as more advanced technologies such as tracing solutions, can provide information and insight so that more circular specifications can be devised. This category of technology can also provide systems and interfaces for procurers and suppliers to share information and collaborate toward shared objectives. Technology for supply chain transparency can provide sufficient information regarding the provenance of materials, so that the transition from a single to a multi-sourcing strategy might be implemented. With these elements, it is thus described how a technologically driven procurement strategy can stimulate the circular economy in the aquaculture industry.

Sammendrag

Sirkulærøkonomien har i nyere tid vært sentralt i å redusere miljøpåvirkningen av industrier. Dette oppnås ved å lukke material- og energikretsløpet i samsvar med prinsippene gjenvinning, resirkulering og verdi-bevaring. Imidlertid krever den omfattende innføringen av sirkulærøkonomi en stimulans. I denne oppgaven vil vi utforske hvordan bruken av en teknologisk støttet innkjøpsstrategi kan stimulere leverandører i oppdrettsindustrien til å levere mer sirkulære produkter og materialer. Denne oppgaven er skrevet med inspirasjon fra prosjektet POCOplast. Ved å kvalitativt undersøke to aktører som er inkludert i dette prosjektet, Grieg Seafood og Flokk, ble potensialet til innkjøpsfunksjonen for å stimulere sirkulærøkonomien utforsket, samt hvordan teknologi kan forsterke disse effektene. Grieg Seafood er en stor forbruker av plast og plast er et viktig materiale for deres oppdrettsvirksomhet. Grieg Seafood har som mål å stimulere sirkulærøkonomien ved å øke bruken av resirkulert plast, samtidig som de identifiserer muligheter for at deres plastavfall kan brukes i andre bransjer. Flokk er allerede en etablert forbruker av resirkulert plast i møbelindustrien og er interessert i å øke tilgangen på post-consumer plast. Et rammeverk ble brukt for å knytte litteraturen om sirkulært innkjøp og teknologi til disse kvalitative funnene for å analysere resultatene. Innkjøps potensiale for å stimulere sirkulærøkonomien ligger i utviklingen av kriterier og spesifikasjoner som er i tråd med organisasjonens overordnede strategi for sirkulærøkonomi. Dette inkluderer både graden av sirkularitet til produktene som kjøpes inn, og forretningsmodellene som brukes. Ved implementering av sirkulære forretningsmodeller er det viktig å opprettholde prinsippene for gjenbruk og bruk av sirkulære materialer for å oppnå en positiv miljøpåvirkning. Med økt sirkularitet og modenhet av konseptet kan kostnadseffektiviteten til sirkulære produkter øke, samtidig som bekymringer knyttet til kvalitet og levetid kan reduseres. Teknologi, både grunnleggende teknologi som ulike IKT-løsninger og mer avanserte teknologier som sporingssystemer, kan gi informasjon og innsikt slik at mer sirkulære spesifikasjoner kan utarbeides. Denne teknologikategorien kan også tilby systemer og grensesnitt for innkjøpere og leverandører slik at informasjon kan deles, og at det kan samhandles mot felles mål. Teknologi for gjennomsiktighet og åpenhet i verdikjeden kan gi tilstrekkelig informasjon om opphavet av produkter og materialer, slik at en overgang fra en enkelt-leverandør strategi til en fler-leverandør strategi kan innføres. Med disse elementene er det da beskrevet hvordan en teknologisk støttet innkjøpsstrategi kan stimulere sirkulærøkonomien i oppdrettsnæringen.

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1 Introduction

The concept of circular economy (CE) is a rapidly growing subject of research and application as it attempts to conceptualise a sustainable integration of economic activity and environmental well-being (Murray et al., 2017). Research on CE acknowledges the fact that there is not an inexhaustible supply of raw materials, as well as that the environment does not possess an unlimited capacity to absorb pollution and CO₂ emissions (Murray et al., 2017). The operationalisation of CE in practise may come in many forms, such as policies and sustainable business models. From a business perspective, CE is simply put, the reduction of raw material input and waste output, typically achieved through maximising product lifetime. Firstly, with a prolonged lifetime as a product and then the lifetime of the materials by recycling. Closing the loop has been one of the main ideas of CE, which is the reduction of the input of virgin materials by reusing goods and materials in the value chain (Wells & Seitz, 2005). However, CE cannot be achieved only through activities of a single company, it is more the collaboration of multiple companies. These often influence each other throughout the value chain, which in turn increases the circularity of the entire value chain (Brown et al., 2021). Murray et al. (2017) proposes a definition of CE in which planning, resourcing, procurement, production, and reprocessing are designed and managed to maximise ecosystem functioning and human well-being.

Various exploratory studies are done on the concept of CE and its application, and many mention procurement as a central business function to achieve this economic model (Murray et al., 2017). Procurement is traditionally the task of discovering and agreeing terms and purchasing goods and services from an external source (supplier), with the intention of achieving the lowest price while also considering aspects such as quality, quantity, and location (Laffont et al., 1993). Witjes and Lozano (2016) proposes a framework that suggests that collaboration between suppliers and procurers can lead to a reduction in raw material consumption and waste generation. This framework was originally developed for public procurement scenarios. A significant portion of the currently published research is conducted in public procurement settings, which may stem from how public procurement is more regulated than private procurement (Stentoft Arlbjörn & Vagn Freytag, 2012). However, regulations are catching up to the private sector as well, with stricter policies on sustainability reporting. There is also a growing demand for sustainable products and operations throughout value chains, which may reward firms who choose to prioritise sustainability more than the bare minimum set by regulations. Furthermore, the framework promotes the development of more sustainable business models with the aim of contributing to CE, such as the product-service system (PSS) business model. Mont (2002) defines PSS as "a marketable set of products and services capable of jointly fulfilling a user's need. The product/service ratio in this set can vary, either in terms of function fulfilment or economic value" (Mont, 2002). PSS intends to reduce consumption and its burden on the environment by changing from a fully product-focused business model to a mix of products and services. Services can be provided in addition to the necessary products to fulfil consumers' needs in a more dematerialised sense. Witjes and Lozano (2016) cites Casadesus-Masanell and Ricart (2010) on business models being a reflection of the company's strategy. Casadesus-Masanell and Ricart (2010) contends that business strategies are composed of two different sets of elements: the concrete choices made by management about how the organisation must operate, and the consequences following the choices. Procurement contracts are a significant portion of the choices a management team must make to realise its business strategy, with the consequences playing an important role in the result of the strategy. Every industry is affected by new sustainability drivers. This requires a renewal of strategies to remain competitive, where innovation of business models is credited to making businesses grow faster in this environment (Casadesus-Masanell & Ricart, 2010). Technology is mentioned to be one of the main drivers of this new competitive environment. Building on these propositions, it is of interest to examine what role technology can be in driving procurement strategies to stimulate CE, both for societal good and also in empowering competitiveness in a fast-changing environment.

1.1 Background and motivation

The motivation for this thesis is the POCoplast project (Pathways to sustainable post-consumer plastics in aquaculture). This project group aims to increase the sustainability of Norwegian aquaculture by using the concepts of CE. Furthermore, this thesis will also build on previous work. This work looked at how tracing technology could be leveraged to improve decision making in procurement. The aim of this thesis is thus to elaborate on concepts and explore their real-world applicability. In the following subsection, we describe the POCoplast project and some of the research the project group has conducted.

POCoplast

POCoplast is a collaboration project between SINTEF, NTNU, and actors from Norwegian aquaculture, as well as the Bellona Foundation. By collaborating with actors from all parts of the aquaculture value chain, POCoplast investigates opportunities for sustainable use of post-consumer plastics in Norwegian aquaculture. The project aims to develop knowledge on how the principles of CE can be utilised to achieve a more sustainable plastic value chain. The POCoplast project was initialised in 2020 and is expected to last until 2023. POCoplast takes a holistic approach to investigate the drivers and barriers for Norwegian aquaculture to transition towards CE. The mapping of the current situation of the plastic value chain in Norwegian aquaculture is described in a report by Damman et al. (2022).

The authors of this master's thesis were introduced to POCoplast in fall 2022 as part of a specialisation project, which is commonly performed as a precursor to the master's thesis. An explanation of the research and a summary of the results of the specialisation project will be presented in the upcoming subsection. POCoplast provides a powerful knowledge base and a unique learning alliance with actors. Figure 1 is an illustration of the participating actors in POCoplast. The illustration is purely a conceptual value chain of how recycled plastics could flow in a circular economy. The two main actors for this master's thesis are the salmon farming company Grieg Seafood and the furniture producer Flokk. Flokk are already an established procurer of recycled plastics for use in their products and are actively looking for new opportunities to supply their production and stimulate the circular economy. Grieg Seafood is a large consumer of plastics, being a central material for their equipment in the ocean. Grieg Seafood aims to increase its sourcing and use of recycled plastics in its operations, while also exploring the opportunities to supply other industries with ocean plastic waste. Specifically, in the POCoplast project, there is interest in the potential of Flokk to introduce new fractions of plastic waste into its furniture production. This is in contrast to how the material flow of plastics typically flows in the current value chains of Norwegian aquaculture, which is mainly linear. The market for recycled plastics is currently quite small in Nordic countries, and imported plastics are substantial (Fråne et al., 2015). This is acknowledged as a major challenge, as the industry is expected to grow significantly. Damman et al. (2022) looks at the issue from a socio-technical system perspective, conceptualizing the sustainability transition of post consumer-plastics as a system of elements. These elements are interrelated and dependent on each other such as technologies, markets, practises, politics, industries, and value chains. Markard et al. (2012) notes that a sustainability transition of a socio-technical system is long-term, multidimensional, and fundamental transformation processes. Damman et al. (2022) uses the approach of technological innovation systems (TIS) to analyse the emergence of new technologies within a defined innovation system. This approach focusses more on identifying barriers for the system, while discussing potential actions and strategies to mitigate the effect of these barriers. Although the challenges of transitioning to CE can be quickly credited to low supply and expensive second-hand recycled post-consumer plastics, a socio-technical system approach can provide insight of how the different dimensions of the system can develop and interact to alleviate the challenges.

The TIS-study by Damman et al. (2022) provides a comprehensive overview of the drivers and barriers for Norwegian aquaculture in their transition to CE for post-consumer plastics. The analysis identifies that different actors in the value chain experience different barriers and opportunities for value creation. Damman et al. (2022) notes the uncertainty regarding the quantity and quality of plastic waste in the flow of materials as a prominent challenge, affecting both the supply and demand for recycled plastics. Growing social awareness, policies regarding CE, and increasing prices on virgin plastics are important drivers for increased recycling and reuse. In conclusion of the analysis, Damman et al. (2022) provides two sets of recommendations, one for the actors of the value chain and one for the relevant authorities, both with the objective of stimulating innovation and experimentation with new solutions while facilitating collaboration and sharing of knowledge.

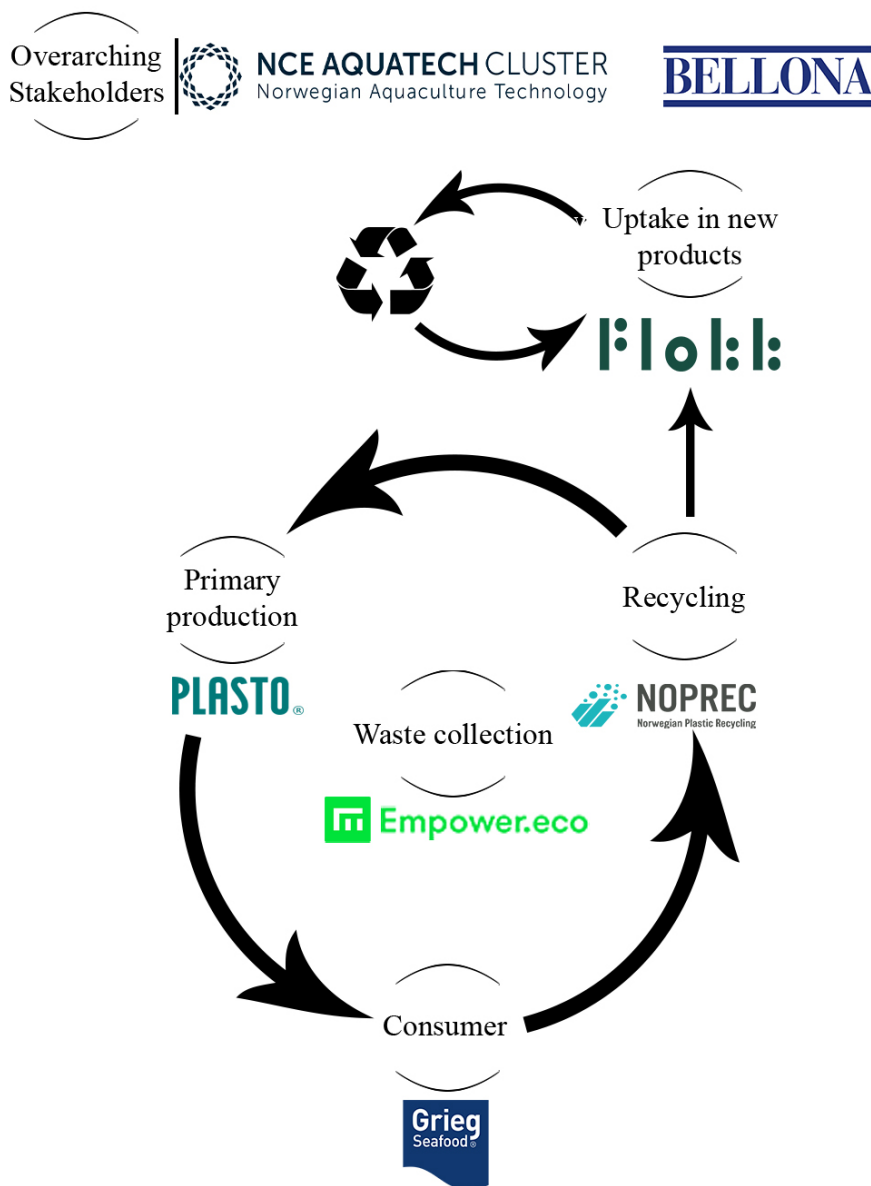


Figure 1: Conceptual circular value chain illustrated with POCOplast participants.

Post-consumer plastics

Post-consumer plastics refer to the plastic waste generated by products that have completed their intended use and are therefore ready to be disposed of, as described in ISO 15270:2008¹. Recycling and sustainable use of plastics is an important aspect of CE as it is a majorly consumed resource. Post-consumer refers to any kind of usage, such as household, industrial, commercial, or institutional usage. POCOplast specifically explores opportunities to increase the sustainable use of plastics in the aquaculture industry.

Specialization project

Prior to this master's thesis the authors conducted a specialization project in the field of purchasing management in collaboration with POCOplast. POCOplast identified tracing technology as a potentially powerful driver for circular economy transformation (Ullern et al., 2022). Discussions with Grieg Seafood, a salmon farming company that participates in POCOplast, revealed interest in how this kind of technology can provide valuable data for documentation and reporting in procurement. Witjes and Lozano's (2016) framework (ProBiz4CE), which linked collaboration and sustainable business models for the circular economy, was used as a baseline model to analyse the literature identified by a narrative review. The specialisation project proposed an enriched framework that synthesises some of the research on using tracing technology for CE from a procurement perspective. Main findings indicate that a well-implemented system for tracing in value chains can be of great benefit for procurers' decision-making. However, the findings also suggest that the implementation and use of tracing technology is a challenge. Similarly to the findings on collaboration for CE from Witjes and Lozano (2016), tracing technology as a tool also relies on collaboration between actors, trust, and commitment. The findings of Witjes and Lozano (2016) and the specialisation project will be elaborated on in the theory section, as it is essential for the structure of the thesis framework and the proposed research methods.

1.2 Problem statement

In finding that tracing technology could improve decision making in procurement, another interesting point is to explore the real-world applicability of the examined concepts. More specifically, this thesis will focus on exploring whether the enriched ProBiz4CE model holds with workers within the industry. This is done through the creation of a thesis framework in which the findings of the specialisation project, as well as the novel literature, are placed within the procurement canvas by Weele and Rozemeijer (2022). The problem statement is thus the following;

Problem statement: "How can a technology driven procurement strategy stimulate the circular economy in the aquaculture industry?"

This can then be further divided into the following research questions.

RQ1: "What is the potential of the procurement function in stimulating the circular value chain?"

¹The ISO 15270:2008 standard provides guidance for standards and specifications about plastic waste recovery and recycling.

This research question will give an indication on the current affairs of the procurement function in the organisation and allows for an exploration of the of the procurement functions role in enabling CE. Included in the potential is the aspect of the value proposition and how procurement-enabled CE can positively affect the economic sustainability of the company. Furthermore, this research question will shed light on which mechanisms in procurement have an effect on stimulating the circular economy. In total, this research question allows for a generalisation of the procurement function's effect and potential in stimulating CE and can be applied to other actors in the industry.

RQ2: "How can new technology assist procurement in stimulating the circular economy?"

This research question can give a description on how relevant technologies can affect operations to stimulate the circular economy. With already knowing the baseline impact the procurement function has on CE (see RQ 1), this research question allows the exploration of how technology can enhance the potential of the function. This research question acts as the main instrument to explore how technological innovations can stimulate CE. Furthermore, the research question will provide an answer on whether the findings of previous work are relevant and applicable to this case.

In combination, these research questions can possibly find an answer to whether a change in strategy to include technological innovations in the procurement function has potential to stimulate the circular economy. An exploration into some of the prerequisites, as well as the possible effects of the strategic change, will also be conducted.

These two research questions are deemed to provide a sufficient answer to the problem statement. These two research questions will be answered using both the findings from the qualitative interviews and the theoretical findings from the literature review. The answer to this research question allows for a description of some perceived effects of circular efforts. Moreover, this research question contributes to give a conclusion to the thesis, and why organisations should pursue the endeavour of a procurement-led CE effort.

1.3 Scope and limitations

This thesis will be conducted as a case study, focussing on actors within POCOplast with participatory interest in the post-consumer plastic value chain. In this thesis these include Grieg Seafood and Flokk. As this is a case study, the scope and boundaries are in some cases naturally defined. In this thesis, we will explore the procurement function and its operations, using the experience of the workers performing the tasks as a basis for the qualitative analysis. Furthermore, the literature findings will be used to substantiate the qualitative study findings and place them in the theoretical context. To give a broader view on how technology can stimulate the circular economy, another actor with the same interest in the use of post-consumer plastic has been included in the case study. The inclusion of this actor will be further explained in the section on methodology. Having this broader view can further give a perspective on how Grieg Seafood's plastic 'customer base' views the use of technological innovations, as well as other CE efforts. As a bonus, the other company can provide a frame of reference for Grieg Seafood on how circular efforts are pursued.

In that this thesis is a case study on the use of technological tools to stimulate the circular economy, there are some inherent limitations that stem from this. As the case study is qualitative, the potential of using a technology-driven procurement strategy to stimulate will be analysed based on this, rather than an economic analysis. It then follows that in depth analyses will not be performed, e.g. quantitative cost assessments. This includes neither the cost nor economic benefits of a potential implementation. Rather, generalised costs

and benefits will be discussed. Moreover, the context in which this thesis is written, as part of the purchasing management specialisation, does not necessarily allow for an in-depth exploration of the specifics of the technology. Nevertheless, these limitations are not considered a significant hindrance to the exploration of the problem statement or the addressing of the research questions.

1.4 Report structure

The thesis is classically structured. Section 1 presents the background and motivation for the choice of subject. Included in this is the problem statement, scope, and limitations that exist for this thesis. In section 2 the relevant literature used to support future findings will be presented. In addition, the framework devised based on this literature will be presented in this section. Section 3 describes the methods used, the reasoning behind the choices made, and how the methods used were designed. Section 4 presents the empirical results of the study. These are analysed and discussed in section 5 according to the research framework. The analysis will then provide the basis for answering the research questions. Ultimately, the conclusion to the research questions and problem statement will be presented in section 6. Each section has its own introduction, providing a brief overview of its content.

2 Theory

In this section the central theoretical concepts which acts as the basis for this thesis will be presented. The literature will give an overview of the central topics of this thesis; the circular economy; the procurement function; and technological innovation. Where applicable and relevant, the intersection between topics will be presented. This is especially interesting in the case of technological innovation supporting procurement in stimulating the circular economy. This section also introduces some of the most prominent critiques on some of the topics and concepts. Further, the ProBiz4CE model will be presented, as well as the enriched model that stems from the previously described specialization project. These topics will be used to support further findings, putting them in the required context, and used to verify the findings from the qualitative methods. In conclusion of this section the research framework will be presented, which is based on the described literature, as well as the aforementioned ProBiz4CE framework and the enriched model.

2.1 Circular Economy

Circular economy's (CE) origin as a concept cannot be credited to a single author or date, but has since the late 1970s gained momentum and been refined into the general concept it is known as today (EMF, 2013). CE is a multifaceted concept, as it has gained traction in a multitude of different schools of thought within industrial economy and ecology. The Ellen MacArthur Foundation (2013) specifically credits the theoretical influences of regenerative design (Lyle, 1996), performance economy (Stahel, 2010), cradle-to-cradle (McDonough & Braungart, 2010), industrial ecology (Graedel, 1996) and biomimicry (Benyus, 1997). The common aspect of theoretical concepts that has contributed to the development of CE is the idea of closed loops, which envisions no waste generation in a closed-loop economy. The Ellen MacArthur Foundation's (2013) commitment to popularise CE has made its definition of the concept widely renowned and is stated as: "an industrial economy that is restorative or regenerative by intention and design" (EMF, 2013). Another renowned definition of the concept is provided by Webster (2015) stating that "a circular economy is one that is restorative by design, and which aims to keep products, components, and materials at their highest utility and value, at all times." (Webster, 2015). Bocken et al. (2016) emphasises the role of business models for CE by defining them as "design and business model strategies slowing, closing, and narrowing resource loops." (Bocken et al., 2016). Geissdoerfer et al. (2017) base their definition on these contributions, among others. They define the circular economy as "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling." (Geissdoerfer et al., 2017). In a later review of circular business models, Geissdoerfer et al. (2020) presents an illustration of CE according to their definition. This is illustrated in figure 2.

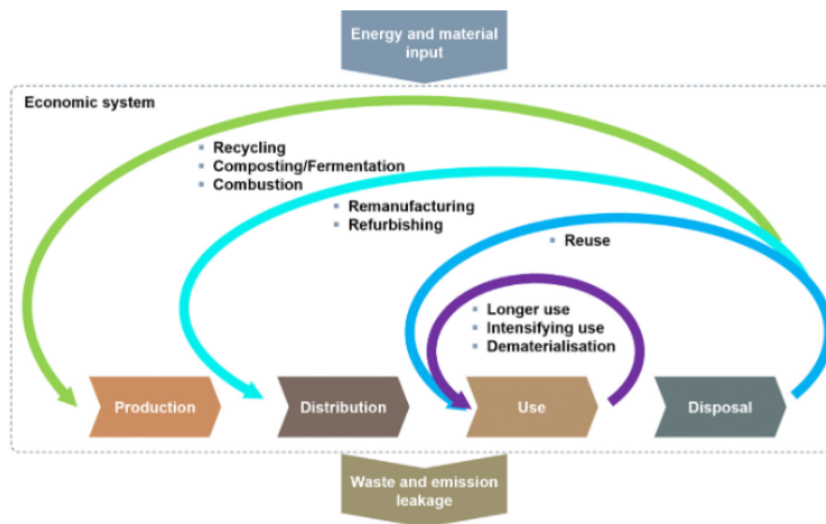


Figure 2: The Circular Economy (Geissdoerfer et al., 2020).

Although CE as a concept is relatively nascent, it has quickly become a hot topic in academia as a potential solution to growing environmental concerns. Industrial economies are also seeing the consequences of the limited assimilative capacity of the Earth, although the limitations of the raw material reservoirs have been apparent for some time (Boulding, 1966). Industries may also see motivation for reuse and remanufactured products, as there is a growing demand from consumers concerned with climate (Prendeville et al., 2014). Geissdoerfer et al. (2017) credits the publication work of the Ellen MacArthur Foundation, as well as its role as a collaborative hub for businesses, policy makers, and academia, as an important factor for the increased attention CE has received. This has enabled consulting agencies to exploit the concept of CE, providing consulting services with the aim of closing loops. Regulations in the form of policy and laws may, however, have had the strongest impact until now in leading companies into trying implementation of CE practises. The concept of CE is promoted in a growing number of governments, including China, Japan, the UK, Sweden, and Finland (Korhonen et al., 2018). The EU through the European Commission strongly promotes the idea of CE in an effort to develop a "sustainable, low carbon, resource efficient and competitive economy" for Europe (European Commission, 2015). The European Commission emphasises how the economic actors, the businesses and consumers, are the key in driving the transition process. Local, regional and national authorities are enablers of the transition into CE, with the EU having the fundamental role of providing regulatory framework in the aim of developing CE.

Challenges of Circular Economy

The European Commission (2015) clarifies that the transition to CE is a long-term involvement process at all levels. This includes EU member states, regions, and cities, businesses, and citizens. The coherence of policy globally is deemed important to help realise the goals and commitments set, such as the Sustainable Development Goals (SDGs) of the United Nations. The European Commission (2015) emphasises how CE transition can contribute to the achievement of the 12th SDG goal, which is ensuring sustainable consumption and production patterns. However, there are significant challenges at the business and infrastructure level, making the practical implementation of closing the loop difficult (Prendeville et al., 2014). Prendeville et al. (2014) mentions some challenges related to logistics, supply chain management, recycling, behaviour change, and over-consumption. Logistics challenges concern the challenge of maintaining a functioning distribution network that can collect products scattered nationally or internationally to a central depot. The lack of infrastructure in some regions adds to the complexity of performing such a product

collection. Lack of information and information flow concerning quality and quantity of products in value chains makes it hard to correctly predict when and where collection should take place. There is also a concern in consumer demand for reused and re-manufactured products, as some have skepticism tied to its quality and functionality. Most of the raised challenges are solvable with investments, but ultimately ties to the barrier most businesses are concerned with in transitioning to CE, economic viability. Product designs must be developed with reuse or re-manufacturing in mind, which generally means products must consist of standardized components or they must generate high value recyclable output (Prendeville et al., 2014). There is an economic cost associated with the design and manufacturing of such products, but there is also the challenge that some products are technically difficult to recycle. This is the case for some types of plastics contaminated with inks and metals (Hopewell et al., 2009). Although it is still possible to recycle such products, it is currently an exhaustive and expensive process, which in turn results in recycled materials ending up as an uneconomical investment compared to virgin material sourcing. Prendeville et al. (2014) raises the particular issue of "cannibalisation", which is the reduction in sales of an older product when a business introduces a new one. In the case for CE, this could be new products of virgin material that lose sales when cheaper remanufactured products are introduced, risking a profit loss.

Circular Business Models

To mitigate the challenges of transitioning and making CE a economically viable way for businesses to operate according to CE principles, a fundamental change in how a business conducts its services may be necessary. Business model is the term commonly used to describe the way a business intends to commit its operations and generate value (Witjes & Lozano, 2016). Casadesus-Masanell and Ricart (2010) proposes that a business model is a reflection of a company's strategy. Zott and Amit (2010) argues that a business model can be viewed as a template of how a company conducts business, how it generates value for its stakeholders, and how it links factors and product models. Stakeholder demand greatly dictates what value is and in turn affects the outlines of the business model. Stakeholder demand for sustainability issues related to the whole life cycle of products and services is growing (Witjes & Lozano, 2016). This is termed "cradle-to-grave" and is commonly used in assessments of impact at each stage of a product's life cycle. This is from resource extraction and processing to manufacturing, transportation, usage and ultimately disposal. As stakeholder demand to reduce the environmental impact of the product life cycle is growing, the value of products and services is changing. Bocken et al. (2014) describes the process of redesigning of business models to capture the growing demand for sustainability value, namely sustainable business models. Categorized into three groups, each group divided into multiple archetypes, Bocken et al. (2014) has identified the central elements that make sustainable business models. The groupings and archetypes are:

- (1) Technological (Maximise material and energy efficiency; Create value from waste; Substitute with renewable and natural processes)
- (2) Social (Deliver functionality rather than ownership; Adopt a stewardship role; Encourage sufficiency)
- (3) Organisational (Repurpose for society/environment; Develop scale up operations)

Figure 3 illustrates the archetypes of sustainable business models and examples of what characterises them according to Bocken et al. (2014).

Groupings	Technological			Social			Organisational	
	Archetypes	Archetypes	Archetypes	Archetypes	Archetypes	Archetypes	Archetypes	Archetypes
	Maximise material and energy efficiency	Create value from waste	Substitute with renewables and natural processes	Deliver functionality rather than ownership	Adopt a stewardship role	Encourage sufficiency	Repurpose for society/environment	Develop scale up solutions
Examples	Low carbon manufacturing/solutions	Circular economy, closed loop	Move from non-renewable to renewable energy sources	Product-oriented PSS - maintenance, extended warranty	Biodiversity protection	Consumer Education (models); communication and awareness	Not for profit	Collaborative approaches (sourcing, production, lobbying)
	Lean manufacturing	Cradle-2-Cradle	Solar and wind-power based energy innovations	Use oriented PSS- Rental, lease, shared	Consumer care - promote consumer health and well-being	Demand management (including cap & trade)	Hybrid businesses, Social enterprise (for profit)	Incubators and Entrepreneur support models
	Additive manufacturing	Industrial symbiosis	Zero emissions initiative	Result-oriented PSS- Pay per use	Ethical trade (fair trade)	Slow fashion	Alternative ownership: cooperative, mutual, (farmers) collectives	Licensing, Franchising
	De-materialisation (of products/packaging)	Reuse, recycle, re-manufacture	Blue Economy	Private Finance Initiative (PFI)	Choice editing by retailers	Product longevity	Social and biodiversity regeneration initiatives ('net positive')	Open innovation (platforms)
	Increased functionality (to reduce total number of products required)	Take back management	Biomimicry	Design, Build, Finance, Operate (DBFO)	Radical transparency about environmental/societal impacts	Premium branding/ limited availability	Base of pyramid solutions	Crowd sourcing/funding
		Use excess capacity	The Natural Step	Chemical Management Services (CMS)	Resource stewardship	Frugal business	Localisation	"Patient / slow capital" collaborations
		Sharing assets (shared ownership and collaborative consumption)	Slow manufacturing			Responsible product distribution/promotion	Home based, flexible working	
		Extended producer responsibility	Green chemistry					

Figure 3: Sustainable Business Models Archetypes (Bocken et al., 2014).

Witjes and Lozano (2016) specifically raises the concept of product-service systems (PSS) as a business model that fits the principles of CE. The aim of a PSS is to reduce the burden on the environment through consumption and contributes to a more efficient use of resources (Mont, 2002). Mont (2002) notes five main elements of a PSS, which are illustrated in Figure 4

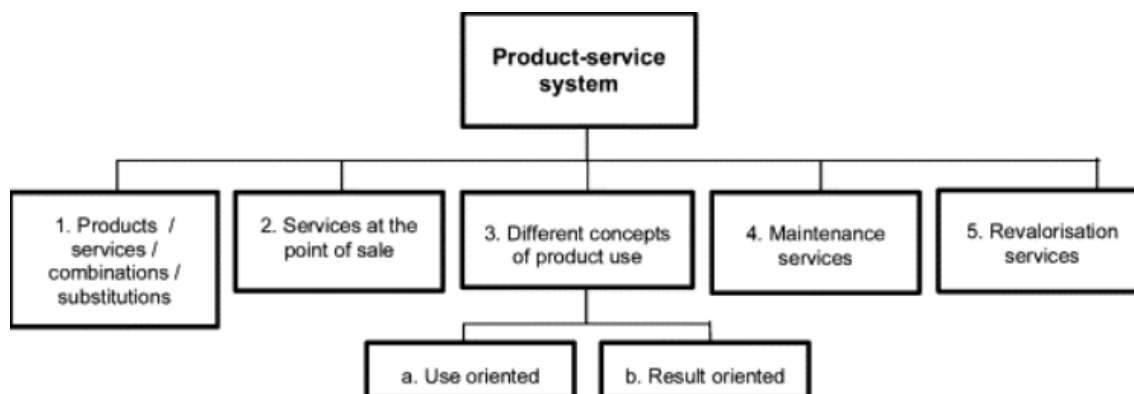


Figure 4: Elements of PSS (Mont, 2002).

The differences of a PSS compared to a traditional buy, use, and throw away approach found in traditional business models are distinct. PSS requires a significantly closer relationship between supplier and buyer, as it is the use of a product that is sold, not the products itself. This is enabled by the supplier leasing its product to the buyer and maintaining its function over time to maximise its life. Should the product reach a state

where it traditionally is scrapped and turned to waste, it is rather recovered in order to restore its function and value. However, this system requires collaboration and willingness to commit to a shared ownership of the service. A model for collaboration and sustainable business models for CE is proposed by Witjes and Lozano (2016), which is elaborated on in an upcoming section on ProBiz4CE.

Bocken et al. (2016) describes the strategy of PSS as "access and performance model" in their exploration of circular business model strategies. It is one of the business model strategies which primarily aims to slow down loops. "Extending product value" is another business model innovation within the same category. It is defined by exploiting residual value left over from products in its life cycle, such as return initiatives or re-manufacturing of parts, which already are quite common in the clothing and car industries respectively. The "classic long-life model" is simply defined by products designed for durability and repair services, typically found in luxury branding and white goods. The "encourage sufficiency" innovation is similar to the previous one in its design and maintenance principles, but also accompanied by promoting a non-consumerist approach to sales and marketing. This means that sales representatives actively promote customers to take good care of their products to make them last as long as possible, while also providing good warranties and repair services in case of need. These four business model innovations make up the "slowing the loop" category of circular business model strategies presented by Bocken et al. (2016). However, there are also two innovations found in the category of "closing the loop", namely "extending resource value" and "industrial symbiosis". "Extending resource value" is a more extensive edition of the "extending product value", as it aims to collect typically "wasted" materials and resources to turn them into new forms of value. "Industrial symbiosis" is a process-orientated solution where the residual output from one process is fed into another process where it can be processed for value.

Critiques of Circular Economy

During its rise as a concept over the past several decades, CE has also accumulated significant critiques for varying reasons in different academic fields (Corvellec et al., 2022). In a compilation of critiques from nearly 100 publications and reports, Corvellec et al. (2022) takes a pragmatic look at the possibilities of developing circular material flows. Critiques span across the theoretical, practical, and ideological grounding of circular economy and circular business models. Corvellec et al. (2022) emphasise that their work is not intended to defer the development of CE, but rather to highlight issues that must be addressed for it to be a viable route to sustainable economic development.

The definition of CE is cluttered, being a concept that has been re-examined over the years (Reike et al., 2018). Kirchherr et al. (2017) examines 114 definitions originating from both scholars and practitioners, revealing how the term differs to different people. Kirchherr et al. (2017) points out how different definitions of CE are adopted for different theoretical uses, although most definitions share its basic concepts. However, this results in the fact that the concept and its research become fragmented (Korhonen et al., 2018). Korhonen et al. (2018) claims that CE "is not a theory but an emerging approach to industrial production and consumption". Its current conceptualisation creates excitement and enthusiasm, as its wide definition seems like a solution to many sustainability problems (Blomsma & Brennan, 2017), its notion appeals to the masses, but it is unclear what it is actually about (Velis & Vrancken, 2015). It cracks when it comes to operationalising the concept, as there are unresolved issues concerning its definition (Blomsma & Brennan, 2017).

Corvellec et al. (2022) raises the issue of CE seemingly neglecting established knowledge. The concept is often praised for ultimately being a means of eliminating all waste, fully closing material loops. However, this would be practically impossible considering the thermodynamic teaching that one cannot create

nor destroy matter (Giampietro & Funtowicz, 2020). Resources that are in a loop will have entropy and dissipation in the form of a loss of quantity and quality, which would require injection of new material and energy to replace the losses (Cullen, 2017). CE may also neglect how consumption can grow in tandem with improving resource efficiency. Jevon’s paradox, the potential rebound effect of increased consumption and usage of materials might offset efficiency improvements at the individual product level (Schröder et al., 2019). These are some of the common critiques found towards the clarity of the theoretical and practical conceptualisation of CE.

Corvellec et al. (2022) cites Skene (2018) on how products are rarely manufactured, purchased, disposed of, and recycled in the same place. Taking this into account, the task of recovering products from global value chains for reuse is an extensive process. It would be a challenging global reorganisation of consumption and production to facilitate the reuse of waste in new activities (Savini, 2019). This is an important consideration in identifying how extensive investments must be to realise the environmental benefit of CE. Korhonen et al. (2018) also note how engineering and natural sciences have been the main contributor to research on the concept, which reflects in how CE may neglect the social pillar of sustainability (Blomsma & Brennan, 2017). Murray et al. (2017) suggests that the social impacts of the concept are unclear and that there are important moral and ethical issues which are missing from its construct. These are points to keep in mind when arguing the sustainability potential of CE, whether it is a positive for only the economy or for the social and environmental aspects of sustainability as well. In conclusion, Corvellec et al. (2022) proposes that producers and the state must pursue a modest path to CE, as a concrete solution to actual problems.

2.2 Procurement

Procurement’s role in business organisation is more and more recognised as key business drivers, where the function can contribute significantly to both the bottom line and the top line (van Weele, 2018). Procurement is defined in Weele and Rozemeijer (2022) as: ”The management of the company’s external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the company’s primary and support activities is secured at the most favourable conditions covering the materials, information and money flows up to the point of consumption.”

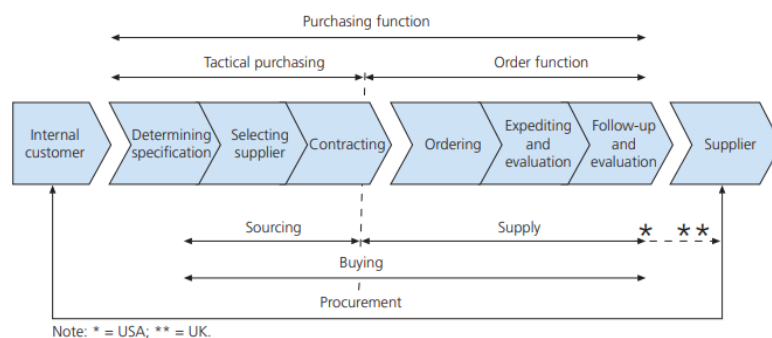


Figure 5: Linear procurement process model (van Weele, 2018)

This procurement model is visualised in figure 5. The procurement function covers seven activities aimed at achieving the overall objectives of the organisation, and are described in van Weele (2018). These include an assessment on whether the organisation should produce the product or component themselves, or whether it should be procured. The next step is to specify the product or service. When the specification is determined, the selection of the most favourable supplier should be made. The decision of which contract to use, along

with the preparation and conduction of negotiations to establish the best possible agreement, should then be undertaken. All these steps are part of tactical purchasing. The order function includes the placement of orders with efficient purchase orders and thorough follow-up routines. Monitoring and control of orders to verify that goods are delivered in accordance with the terms should also be carried out. Lastly, supplier follow-up and evaluation, including settlement of claims and disputes and supplier rating and ranking, is the final procurement activity defined by van Weele (2018).

Procurement canvas

In the procurement canvas, Rozemeijer describes how different procurement objectives relate to various benefits, such as cost-reduction, product quality improvement, and driving sustainability in the supply chain, among others (Weele & Rozemeijer, 2022). With these objectives in mind, a strategy can be devised where focus is laid on enablers and processes in procurement to achieve these said objectives.

Source: Rozemeijer, F. (2008). Purchasing myopia revisited again? *Journal of Purchasing & Supply Management*, 14, 205–207.

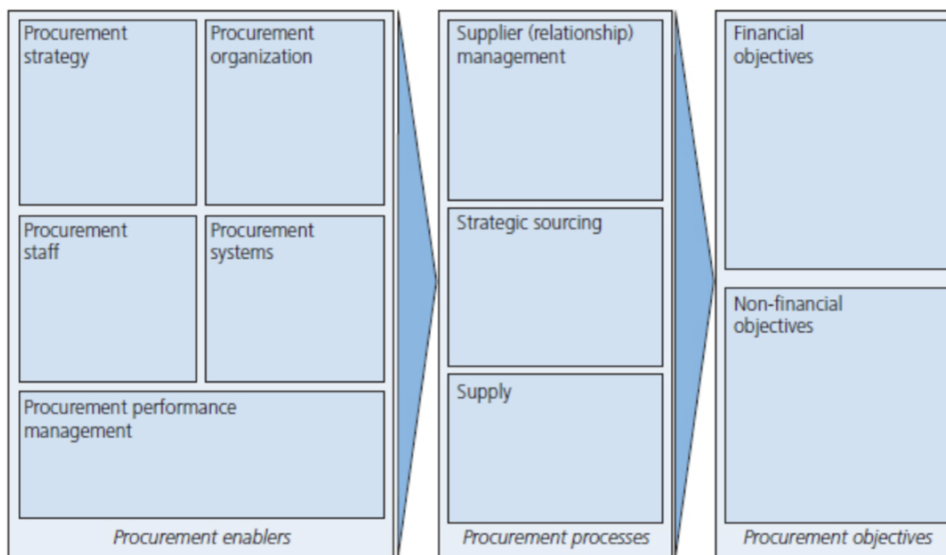


Figure 6: Procurement Canvas defining objectives, strategies and actions (Weele & Rozemeijer, 2022)

Figure 6 illustrates the relationship between the procurement enablers, processes, and objectives. Within procurement processes there are three areas which are defined; supply, strategic sourcing, and supplier management. Weele and Rozemeijer (2022) continues with the following descriptions of the processes. In supply, procurement management is aimed at optimising the purchase-to-pay process, as well as the flow of incoming materials. Processing the purchase-to-pay process entails the handling of procurement requisitions, purchase orders, and expediting, as well as developing efficient digitalised routines. Materials and supply planning includes the issuing of material plans and delivery schedules to suppliers, the reduction of lead times, and the monitoring of supplier delivery performance, among others. Strategic sourcing is described as the process of deciding on supplier selection based on various deciding factors. These factors could be the number of suppliers required per spend category, the way the supplier relationship should be conducted (partnership or competitive bidding), or they could be whether a product should be sourced globally or locally. Supplier management entails the systematic management of the company's suppliers. Decisions on this process could be whether to pursue a single or multiple sourcing strategy, finding the best target for future cooperation, and deciding what to do with underperforming suppliers. These decisions

should be made based on detailed data and should be carefully implemented.

These core processes should be in focus, but Weele and Rozemeijer (2022) also describes five enablers that should be in place to perform these processes. The procurement strategy should be explicit and clearly defined, with a formalised planning process to have the best chance of successfully integrating the procurement strategy in the company's overall strategy. They continue by describing that the more competitive the business context and the more mature the technology is, the higher the pressure on the procurement department to contribute to the top and bottom line. Furthermore, top management support is described as one of the most important enablers for the procurement strategy.

Procurement systems, such as digital information and communication technology, are also considered an important enabler for the modern procurement function. It is further described that various systems can contribute by providing data so that spend analyses can be performed and buying behaviour can be analysed. This is in addition to automating processes such as the purchase-to-pay activity. Organisation entails the way the business formally sets up the procurement process, the coordination of said process across multiple business units, the degree of centralisation of procurement activities, as well as the definition of primary procurement tasks and responsibilities. Staffing includes the different knowledge, skills, and competences that are required within the procurement function. Within this, the decision of whether to establish a training and development programme can be considered. Lastly, Weele and Rozemeijer (2022) includes performance management as a procurement enabler, where the performance of the function can be measured in terms of the overall financial and non-financial value contributing to the organisation's success. Points of consideration on this point could include which metric should be measured and evaluated, how it can be measured, the practical aspects on the introduction of such a measuring system, as well as how the procurement process should be benchmarked.

Towards purchasing excellence

The procurement canvas model shares some similarities with Monczka's "towards purchasing excellence" model, as cited by van Weele (2018). This model includes a more detailed subdivision of the processes found in the procurement canvas, as seen in figure 7.

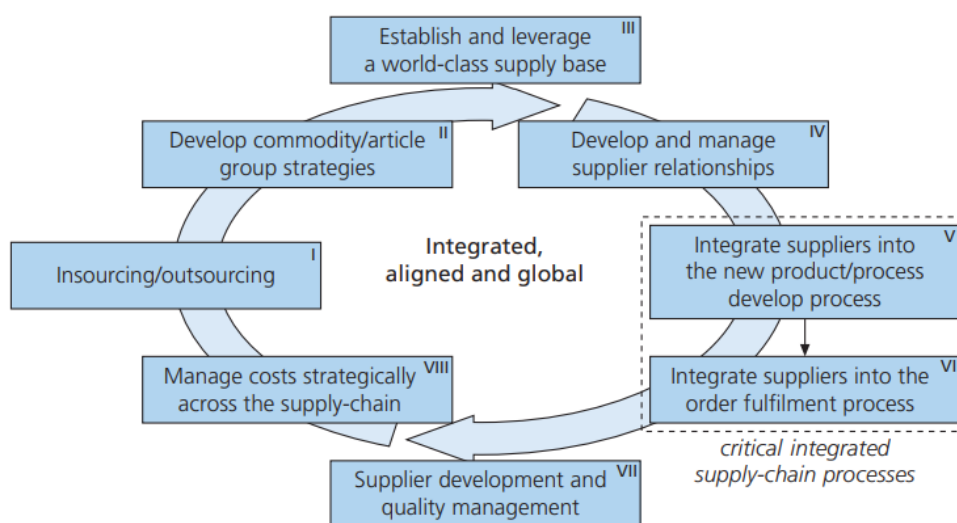


Figure 7: Procurement processes (van Weele, 2018)

Firstly, Monczka defines the process of insourcing and outsourcing. Here, a deciding factor is whether an activity should be performed within or outside the company. This should be decided on the criterion on whether the activity contributes to achieving a competitive advantage and whether the activity is performed in a competitive way. Should this not be the case, then the activity should be outsourced. The activity can, however, be brought back should analyses deem it prudent. The development of commodity strategies is the second step. Here a clear and detailed picture of where and on which commodities an organisation spends the most resources. In addition, in this point, the number of suppliers and whether that amount should be reduced are included. The next step of establishing and leveraging the supply base is closely linked to this, where the number of suppliers per category is needed, and which qualifications and conditions these suppliers should meet. All three steps are included in the strategic sourcing process on the procurement canvas.

Developing and managing supplier relationship is in Monczka's model the fourth process that should be considered. This involves grouping suppliers into distinctive categories. A way in which suppliers could be categorised is into commercial partners; preferred suppliers and supplier partners. Supplier partners are often collaborated with closely to develop new technologies, products, and business opportunities. On the opposite end, commercial partners are only expected to deliver goods and services in agreed upon terms. Preferred suppliers can be seen as a middle ground, where mutual objectives and improvement programmes are developed bilaterally, but integration is not necessarily as thorough as that with a supplier partner. The next step described is the integration of supplier partners in product development and further develops the relationship. Supplier integration into the order fulfilment process can then be done to further work towards the goal of increasing customer satisfaction. Supplier development and quality management are the stage in which suppliers are challenged to provide ideas that can increase performance, such as product design or manufacturing technology. These four processes again correlate to Rozemeijer's process of supplier management, but giving a more detailed description of the activities it entails. Rozemeijer's process of supply is not necessarily represented in Monczka's model, where Monczka has instead included strategic cost management as the eight and last step. Here, identification of all costs, cost drivers, and strategies for reducing or eliminating these should be devised. A sharing of these cost savings should be done, so that all parties may see the benefits of this process.

Another difference between the two models is the separation of the processes and enablers in Monczka's model. These enablers are visualised in figure 8. These enabling processes share many similarities with Rozemeijer's model. Nevertheless, a brief description of each process is included.

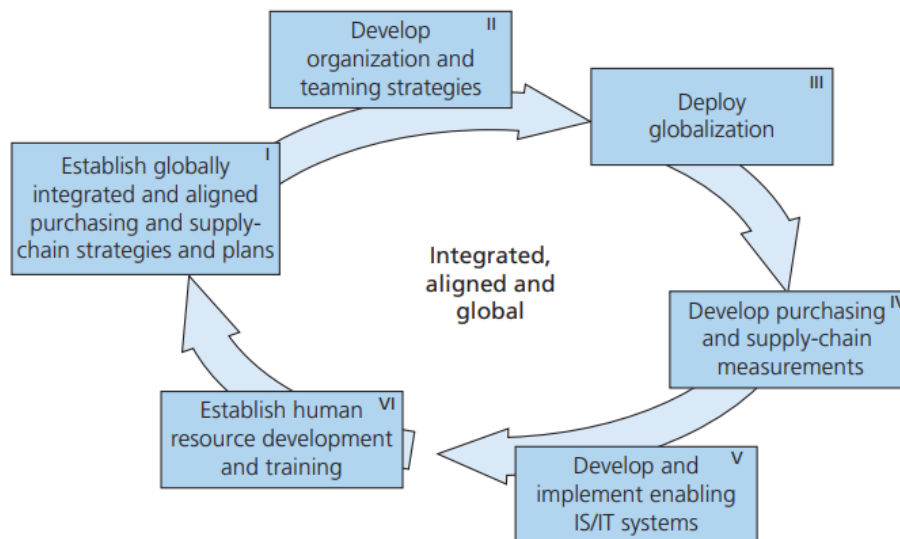


Figure 8: Procurement enablers (van Weele, 2018)

The first of Monczka’s enabling processes is the act of establishing globally integrated and aligned procurement and supply chain strategies. These should support the overall business strategies of the organisation, while reflecting the strategic priorities. The development of organisational and teaming strategies is the second enabling process. Here, the aforementioned strategies and plans should be developed in close collaboration with the stakeholders concerned and communicated thoroughly. Another element of this enabling process is the training and education of the workers so that cross-functional teams can be established. The third step is the deployment of globalisation and entails an international approach towards their sourcing strategies. This requires that the organisation has sufficient knowledge about the culture and legal requirements of the sourcing market they enter. The development of procurement and supply chain performance measurement systems is the fourth step described. This step is the full equivalent to Rozemeijer’s enabling process of procurement performance measurement, and thus further description is superfluous. The development and implementation of advanced IT systems is the fifth procurement enabling process. This process gives the opportunity to simplify and automate purchase-to-pay transactions, as well as provide better overall data for the process. Monczka’s sixth and final enabling process described in van Weele (2018) is the establishment of human resources development and training. This process gives the organisation the required competencies to perform the procurement task in an unsurpassed manner.

While Rozemeijer gives in the procurement canvas model a good overview of the processes needed to achieve financial and non-financial gains, as well as the enablers needed in order to see them, Monczka gives a more detailed overview of each individual step in the processes. Both of these models can serve as an overview of how to sufficiently organise a strategy and activities to perform the procurement function.

Circular procurement

Circular procurement is defined by the United Nations Environment Programme as ”(...) when the buyer purchases products or services that follow the principles of the circular economy, supporting the assessment of designing, making, selling, reusing and recycling products to determine how to get the maximum value from them, both in use and at the end of their life” (United Nations Environment Programme, 2021).

The role of procurement in the transformation into a CE, as well as the implications of CE for procurement, is sometimes seen as of secondary importance (Eisenreich et al., 2022). This has been noted as surprising, as procurement has been identified as one of the most critical functions in achieving CE related objectives (Xu et al., 2022). Consequently, various publications have defined the role of procurement in achieving CE as an area that deserves future investigation (Eisenreich et al., 2022; Xu et al., 2022). Rejeb and Appolloni (2022) finds that in order to encourage circular procurement, three factors should be prioritized:

- Services rather than products
- Product conception, operation and disposal
- Market dialogue

Continuing, Neessen et al. (2021) finds that the role of individual purchasers to transform into a CE is to act intrapreneurial, sustainability minded and knowledgeable about the circular economy. In addition to this, sharing responsibility with budget holders and organisations with processes in place that ensure the inclusion of circularity in purchasing projects is found to be more successful in circular procurement than other organisations. Neessen et al. (2021) finally identifies that creating a sense of direction, as well as grasping the complexity of CE acts as drivers for CE.

In describing the firm infrastructure, Eisenreich et al. (2022) continues by finding multiple ways firms must transform in order to accommodate CE changes. Collaboration within the supply chain, as well as outward towards governmental and non-governmental organisations is found to be a central success factor for CE implementation, but nevertheless a research gap, as most authors emphasise the need for collaboration without investigating what it entails (Eisenreich et al., 2022). Future interesting research areas have been identified as exploring how knowledge sharing, collaboration mechanisms, contracts and supply chain integrations can be used to secure secondary raw materials or the establishment of standards for carbon accounting across value chains (Eisenreich et al., 2022). Top management support is repeatedly mentioned as an antecedent for a successful CE practise (Eisenreich et al., 2022; Xu et al., 2022), with Klein et al. (2022) describing that employees are more willing to implement CE practises if targets, objectives, and practises in organisational planning are well integrated. Additionally, it has been found that a lack of focus or prioritisation of CE in the organisation can negatively affect the willingness of workers to embrace CE practises (Klein et al., 2022).

The use of circular procurement can result in a positive financial outcome through market performance, new market value, and reduced resource use (Xu et al., 2022). Continuing, Xu et al. finds that operational performance is positively affected by circular procurement by increasing the organisation's ability to purchase, produce, or deliver products and services efficiently. Environmental performance can be increased as the main tenet of circular procurement is the reduction or elimination of negative impacts of products on the environment and the reduction of the amount of waste generated throughout the life cycle of the product (Rejeb & Appolloni, 2022).

Differences between circular, green and sustainable procurement

Circular procurement shares some similarities with both green procurement and sustainable procurement, although it still has some differences (Rejeb & Appolloni, 2022; Sönnichsen & Clement, 2020). Green (public) procurement (GPP) is defined as "the process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (EU, 2016). This differs

from the definition of sustainable procurement (SPP) used by Sönnichsen and Clement (2020), where it is defined as "a process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only for the organisation, but also for the society and the economy, whilst minimising damage to the environment".

Alhola et al. (2019) finds that some of the differences between GPP and SPP and circular procurement are the change from a product or technology-orientated focus to a network focus on supply chains and other stakeholders. Furthermore, GPP and SPP traditionally use the mechanism of establishing certain environmental specifications and tendering based on these. Continuing, the main negotiation object in circular procurement changes from product orientation to a product service system, and a change from price per product system to a price delivered per service (Alhola et al., 2019). However, it should not be understood that circular procurement is an entirely new concept that supersedes the other, but that it incorporates elements of both GPP and SPP to achieve the goals of environmental improvements, value creation, and social well-being (Alhola et al., 2019). There are also authors who consider the terms so similar that they are compounded into circular procurement (Sönnichsen & Clement, 2020). However, there are some authors who highlight the differences between the terms. Rejeb and Appolloni (2022) describes that green procurement refers to the practise of purchasing products or services that help minimise environmental effects compared to other alternatives that serve the same function or the inclusion of specific predetermined environmental requirements. Further, it is explained that sustainable procurement applies an even wider focus, including elements of safety, health, and social equity. Rejeb and Appolloni points out that circular procurement differs in that it is committed to the zero-waste principle, even after the product's lifespan has ended. With the differences between the terms being highlighted, the term circular procurement is used throughout this thesis.

Technologically enabled procurement

Using digital technology in procurement processes, sometimes referred to as Procurement 4.0 has recently seen increased use, as firms are increasingly under pressure to increase efficiency, cost-effectiveness and sustainability (Corbos et al., 2023). Rejeb and Appolloni (2022) states that the use of digital technology in procurement can contribute to the automation of procurement processes by offering firms higher productivity, improved efficiency, effective decision-making, and optimal organisational profitability. Furthermore, the use of industry 4.0 technologies can establish robust links between the supply chain team and the procurement department and increase the firms' access to all essential data, such as inventory levels, costs, delivery lead times, as well as potential operational hazards. Using technological innovations in procurement, as well as a strong and effective procurement strategy, organisations can optimise their procurement processes and achieve improved CE performance (Bag et al., 2020).

The literature divides the different technologies in two categories; basic and advanced technologies. Basic technology consists mostly of Internet-based solutions, such as e-ordering and e-sourcing. Advanced technology includes the use of the Internet of Things (IoT), artificial intelligence and machine learning, big data analytics, blockchain technologies, and advanced manufacturing technologies such as additive manufacturing (Bag et al., 2020). Rejeb and Appolloni (2022) gives a definition of the different technologies and a description of the effects they can have on circular procurement.

Rejeb and Appolloni (2022) explains that the IoT assists companies as it allows for wireless communication between human devices, computers, and sensors, thus making real time data available from any location. This can assist in circular procurement, as data collection and transmission are automated. This allows for an unrestricted data flow and a unified interface for collaboration. This would then facilitate communication between buyers and suppliers and can assist in contracting, ordering, pricing, and auditing.

Continuing, AI, also including machine learning, is defined as the development of computers that have the capacity to learn, make decisions independently of human oversight, and self-correct in ways that mimic human intelligence. This can assist in circular procurement based on its ability to gather and evaluate market data without the need for human intervention. This can have the effect of reducing waste and greenhouse gas emissions by analysing areas where this occurs, and thus increasing the effects of circular procurement.

Big data analytics can be used in Industry 4.0 as it allows for the processing of magnitudes of data from a variety of sources in order to aid decision making processes, supports data mining and predictive analytics. This can then be leveraged to support circular procurement by optimising supplier selection, purchasing strategies, and logistic plans.

Additive manufacturing is defined as the process of producing components without the need for specialised equipment, by fusing together materials to form a product in a three-dimensional environment. This can influence procurement by giving buyers increased control and agency over the design that is produced. This can then eliminate further manufacturing stages and result in fully functional, unified product features. In addition to this, additive manufacturing can help reduce supply-related risks and help foster both established and new business models.

Lastly, and perhaps most importantly, Rejeb and Appolloni (2022) defines blockchain technology as a digital, decentralised, and distributed ledger where transactions are recorded and appended in chronological sequence to produce permanent and immutable records. Blockchain technology can aid in circular procurement by increasing trust, and thus collaboration, through the concepts of transparency and traceability. By using blockchain technology, it is possible for suppliers without established business relationships to participate in the process. Increased transparency can be leveraged to increase circular procurement by reducing the risk of transactional inefficiencies, theft, poor management, and fraud, among others. In all, blockchain technology can improve the competitiveness, energy efficiency, and waste management of the circular supply chain, especially in resource allocation and scheduling.

2.3 The ProBiz4CE Model

The ProBiz4CE framework is a model created by Witjes and Lozano (2016), which models changing business models from a product focus to a product-service system (PSS). This model is illustrated in figure 9. One of the central elements of the ProBiz4CE framework is closing loops through the recovery and reduction of waste, thus reducing the need for raw materials. A criteria for successful integration of this framework is buyer-supplier collaboration in order to establish both technical and non-technical specifications.

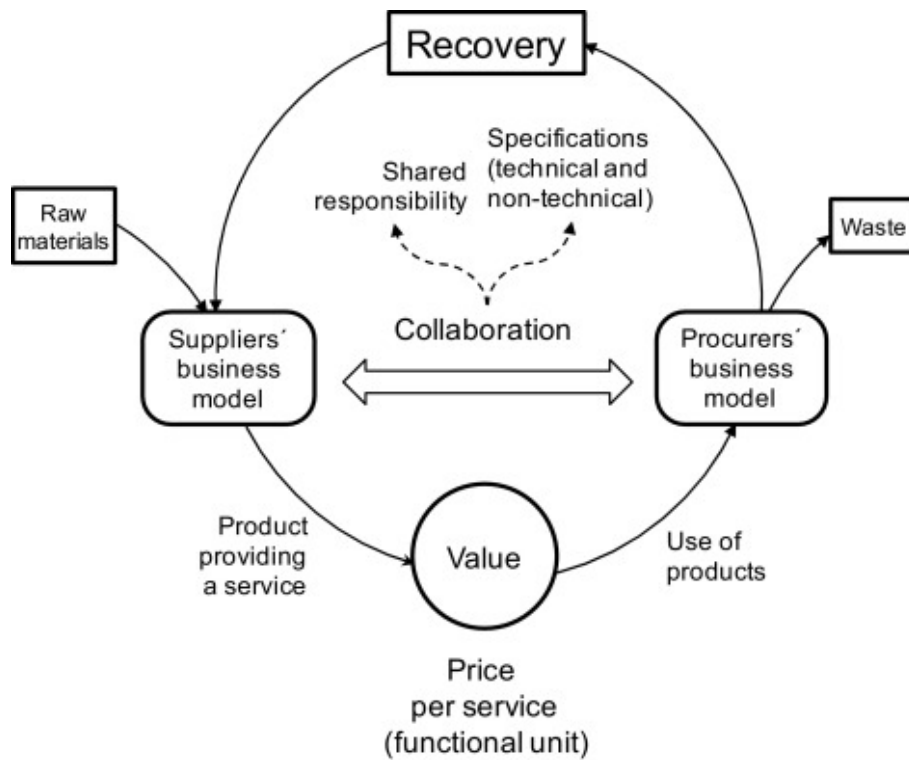


Figure 9: ProBiz4CE (Witjes & Lozano, 2016).

Continuing on this, the emphasis of co-development of these technical and non-technical specification is in contrast to a traditional (linear) procurement process. In this, the purchasing part typically decides on specifications prior to the sourcing stage. In this model, however, the most suitable suppliers are selected during the tendering stage based on corresponding characteristics from the buyers business models; such as environmental or economical performance. This thus means that suppliers with the most corresponding business model to the buyer would naturally act as a better fit with the buyer. This collaboration would then make it easier to achieve the circular goals of closing the loop through recovery and thus see increased material efficiency throughout the product life cycle. Continuing, the functional unit changes from product focus to a PSS, and would thus share the responsibility evenly between buyer and supplier. A key tenet of PSS is that the ownership of the item lies with the supplier, which is responsible for the maintenance and final disposition. The responsibilities of the buyer, however, are to ensure that the products are used fairly and responsibly, while allowing the suppliers access to the product, so that maintenance can be performed (Witjes & Lozano, 2016).

Enriched ProBiz4CE

During the specialisation project, it was of interest to see the theoretical precedent for using tracing technology to influence or enhance the benefits found by Witjes and Lozano (2016) in the ProBiz4CE model. To achieve the results, the findings of a narrative literature review were applied to three key variables from the ProBiz4CE model. This enriched model can be seen in figure 10. Table 1 provides an overview of the literature cited in the specialisation project and in which areas they are applied to enrich the model. The inclusion of the figure 10 is deemed necessary to provide the required background, as it will be the basis for further exploration and elaboration in this thesis. Likewise, table 1 is included to provide an origin of the findings, although this literature is not necessarily used in their own regard in this thesis. A description of the main findings from this specialisation project will in this sub-section be presented.

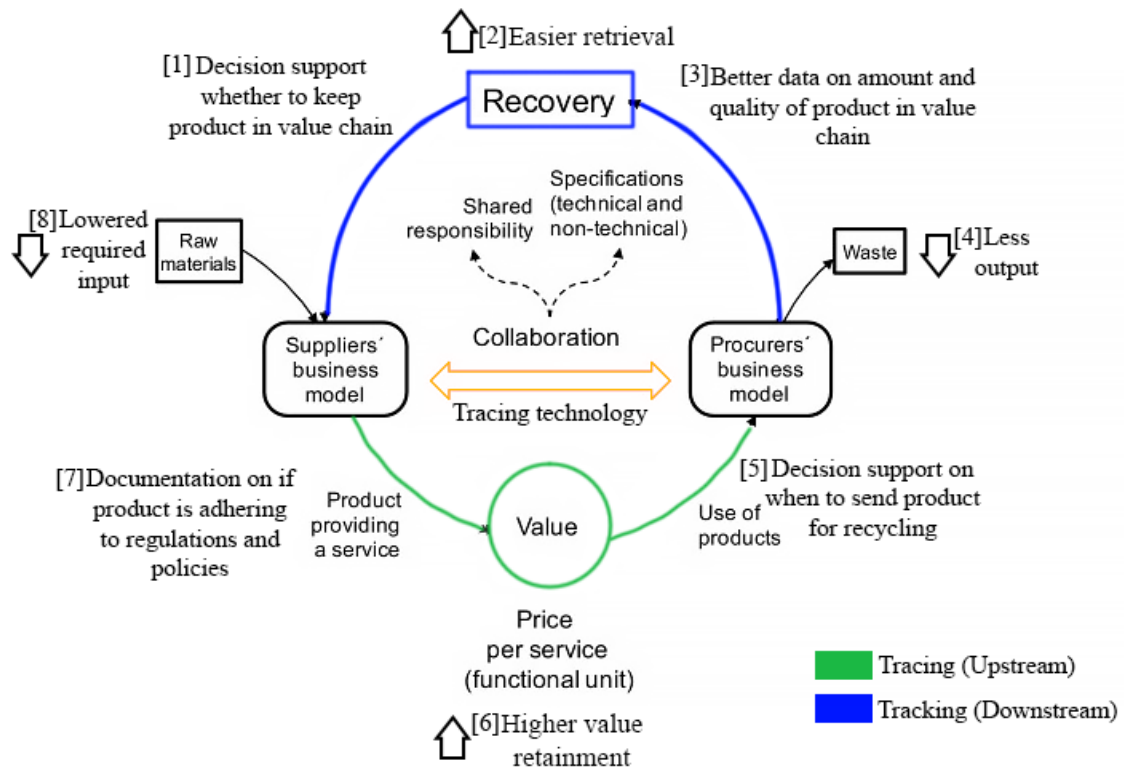


Figure 10: ProBiz4CE for tracing.

On the point of business models, it was found that the limited applications of new business models was a barrier in the circular economy and that cultural and organisational challenges could hinder the implementation of technological innovations. Furthermore, it was found that new practise must be embedded in the organisation mission and vision to see the expected results. A blockchain network for the circular economy might be affected and limited by a multi-stakeholder business model execution, coming from if work culture, relationship and information sharing issues arise from organisational policies and rules. Furthermore, a range of business requirements for an introduction of a tracing solution were uncovered, such as the meeting of stakeholder needs, the improvement of sustainability performance, the increasing of operational efficiency, and the enhancement of supply chain performance.

Collaboration was found in the specialisation project to be required to successfully integrate a tracing solution. This collaboration is built on three sub-themes; goal alignment, partnership trust, and stakeholder acceptance. Collaboration between buyer and supplier was found to be paramount in a transformation to

No.	Description of enrichment	References
[1]	Decision support whether to keep product in value chain	(Khan, Razzaq et al., 2021; Khan, Zia-ul-haq et al., 2021; Kumar & Chopra, 2022; Srαι & Lorentz, 2019; Xu et al., 2022)
[2]	Easier retrieval	(Kumar & Chopra, 2022; Xu et al., 2022)
[3]	Better data on amount and quality of product in value chain	(Hastig & Sodhi, 2019; Kumar & Chopra, 2022; Xu et al., 2022)
[4]	Less output	(Hastig & Sodhi, 2019; Kumar & Chopra, 2022)
[5]	Decision support on when to send product for recycling	(Hastig & Sodhi, 2019; Khan, Razzaq et al., 2021; Khan, Zia-ul-haq et al., 2021; Srαι & Lorentz, 2019; Xu et al., 2022)
[6]	Higher value retainment	(Hastig & Sodhi, 2019; Kumar & Chopra, 2022)
[7]	Documentation on if product is adhering to regulations and policies	(Hastig & Sodhi, 2019; Xu et al., 2022)
[8]	Lowered required input	(Khan, Razzaq et al., 2021; Khan, Zia-ul-haq et al., 2021; Srαι & Lorentz, 2019)

Table 1: References for enriched ProBiz4CE.

circular business models and the circular economy in general. Collaboration through a traceability system could empower and enable further innovative forms of collaboration. Typical challenges of a blockchain-enabled traceability system were explained as related to data access, data sharing, and traceability, as well as trust and transparency between partners and competitors. The point of trust is pointed out as the main driver for the interest in the technology by relating to the properties of immutability and the reliability of the authenticity of the data. Continuing, the importance of trust should not be understated, as it promotes and improves joint decision making and problem solving, thus mitigating potential execution problems. Furthermore, it was explained that the act of performing collaborative activities can itself lead to more trust and commitment between actors. Lastly, the literature indicated that the integration of a blockchain tracing system might negate the dependence on trust, as it is built into the system, thus reducing the need for relational investment into suppliers.

Lastly, on the point of value and recovery, it was found that traceability technology improves sourcing-data, data quality, and unique information storage. These points would then improve recycling, including the disposal of products. Additionally, a blockchain solution could help trace products to recycling and manufacturing, showing the location of specific units in the value chain. This gives the possibility of identifying how and where waste can be used for remanufacturing, either in-house or to a buyer. Moreover, transparency facilitates the implementation of a PSS by moving value generation from product sales to service sales. Lastly, value drivers for a tracing solution built on blockchain technology were identified as mostly being externally focused and include capability assessment, relationship management, and supply market knowledge management.

In conclusion, by enriching the ProBiz4CE framework with the findings of the literature, the specialisation project describes how a blockchain-enabled tracing solution can enhance the model by virtue of collaboration. By providing information on the amount and quality of the products in the value chain, the tools can provide decision support on whether to keep a product in the value chain or if a virgin product needs to be procured. On this point, a tracing solution can provide insight into when a product should be sent to recycling. A blockchain solution can also provide documentation on whether a product adheres to regulations and policies, by providing an irrefutable source on the provenance of the product. To properly see the effects of the tracing solution, an organisation should re-evaluate their business models and possibly change into a

PSS. With a PSS the sustainability of a product might increase through the effect of creating incentives for the development of more robust and recyclable products.

This concludes the theoretical background for the development of the framework in this thesis. A flow chart has been included to give an overview of how the development process was conducted. This flow chart is illustrated in figure 11. The upcoming section goes further in-depth on the framework and its background theory.

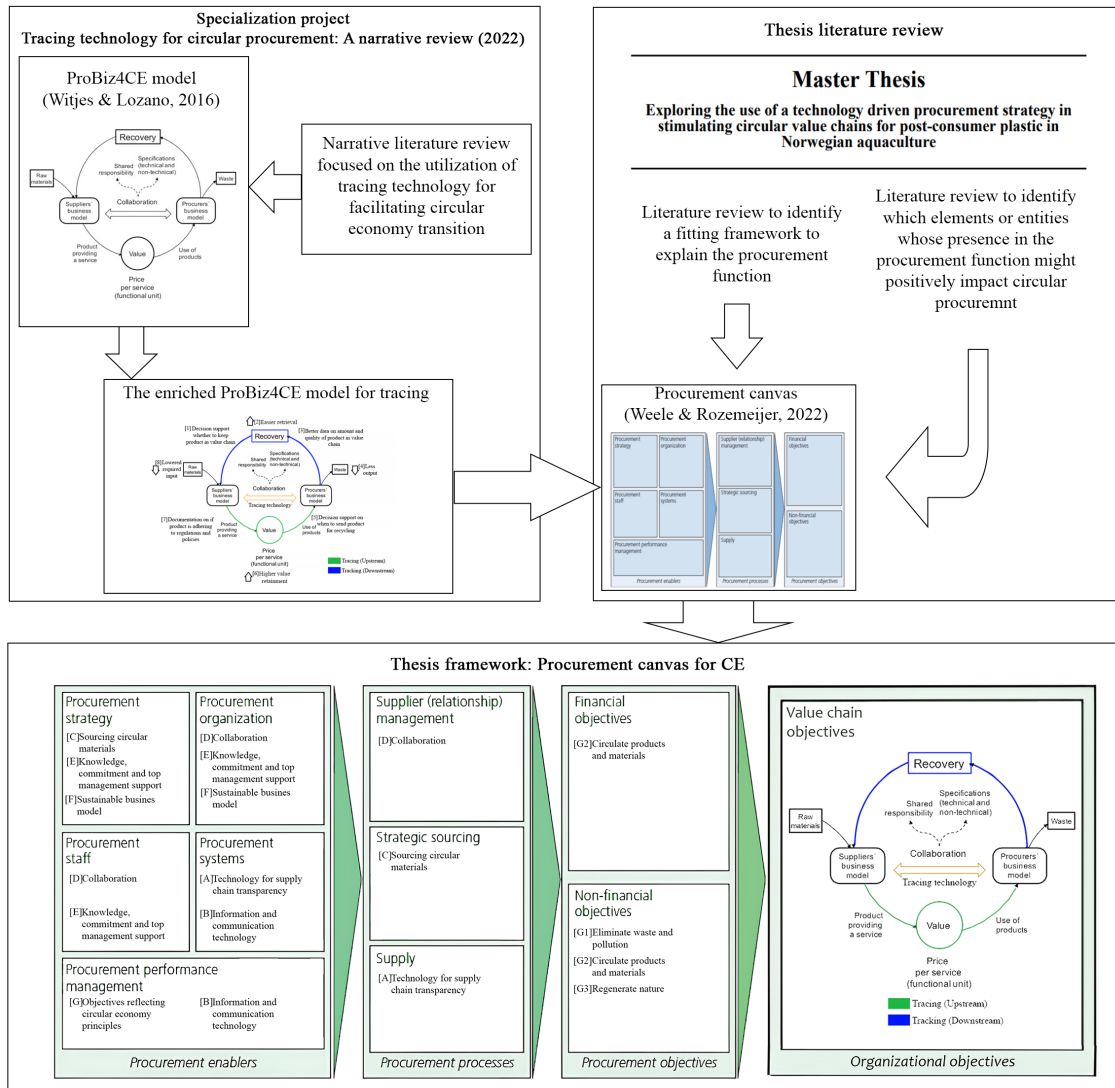


Figure 11: Flow chart of the development process of the thesis framework.

2.4 Thesis framework

By using the enriched framework of the specialisation project as a baseline for a technology-enabled circular value chain, it is possible to expand it further to provide answers to the research questions. Additional literature can be used to provide answers on the effects of procurement in stimulating the circular economy. It is especially interesting to explore the strategic elements and factors required for the design of a technologically driven procurement strategy. Moreover, specific benefits of individual technologies, as well as other challenges in implementing them, can further enhance the findings and help describe the potential of

the strategy.

The potential of a technologically driven procurement strategy hinges on whether or not the implementation of this type of strategy aligns with the goals of the organisation, whether the required capabilities are in order, and whether the potential benefits and challenges are known within the company. The proposed research framework is based on the procurement canvas (Weele & Rozemeijer, 2022) and the enriched ProBiz4CE model from the specialisation project. The results of the narrative literature review in the specialisation project are placed appropriately on the canvas, complemented by the findings of the literature review in this thesis. The canvas is a model of a technologically-driven procurement function of an organisation, supported by procurement objectives, processes, and enablers in the aim of achieving the organisational objective of a circular value chain. Table 2 gives a complete overview of the theoretical findings, which stems from both the specialisation project and the theory in this thesis. Some of the findings from the specialisation project have been combined into a more general description of its contributions. At every instance where there is a combination of findings, it will be elaborated upon in table 2 and table 3. For clarity, the new findings will follow alphabetical numbering to avoid confusion with the previous findings of the specialisation project, as shown in table 1. For example, entry: [A] *Technology for supply chain transparency* is a finding based on the specialisation project findings; [1] *Decision support whether to keep product in value chain*; [3] *Better data on amount and quality of product in value chain* and; [5] *Decision support on when to send product for recycling*. In the thesis framework, there will only be referrals to finding; [A] *Technology for supply chain transparency*, and not any of the findings of the specialisation project.

The framework reflects the authors' propositions of how a technology-driven procurement strategy can stimulate circular value chains, illustrating potential contributing factors for such strategies. Figure 12 is constructed from a synthesis of the literature review in the specialisation project, as well as the literature review carried out in this thesis. Reasoning and elaboration of each of the findings inclusion into the canvas will be presented in the upcoming subsections. Some of the findings are such comprehensive concepts that they may be argued to fit into all parts of the canvas, such as collaboration. However, it was deemed sufficient to rather keep the findings allocated to a select few enablers and processes where they are deemed to fit the most. This was a nuanced decision. Although this may risk the framework not illustrating some noteworthy aspects and connections of technology-driven procurement strategies for CE, it will keep the framework less cluttered and structurally sound. It is believed that this will enable the scope of the upcoming data analysis in light of the framework to be more in depth rather than too broad. It will, however, be highlighted if some of the findings are found to have a significant consequence for an enabler, process, or objective it is not placed within. Most of the findings seem to have interaction with each other, and this will be briefly mentioned where this seems to be the case. However, each explanation is written to be mainly about its own consequences for the procurement canvas.

Technology for supply chain transparency

Technologies that enable greater supply chain transparency are presented as one of the most exciting enablers to transition to CE (Rejeb & Appolloni, 2022). In conclusion to the specialisation project, it was blockchain technology that was found to be the most prominent potential solution for traceability. There are a few arguments as to why this technology can be a driver for circular procurement. Firstly, tracing technology may secure the origin and quality of material/products, thanks to the immutable and secured database it can provide (Rejeb & Appolloni, 2022). This may enable procurers to source circular materials with greater confidence in their actual properties. Authentic data on what materials go into the supply chain is important in relation to planning based on the lifecycle of products and eventual restoration, while also ensuring the functionality of the sourced materials. Additionally, there are industries with strict safety regulations, such

as aquaculture, which demands certification of product quality. Digital technology such as blockchain may be an immutable and trustworthy source of product data to prove that circular products comply with the regulations.

Tracing technology, in relation to other advanced technologies, is also described to enable real-time tracking of products in the value chain (Rejeb & Appolloni, 2022). This can be helpful in stimulating CE for a few reasons. Unique data on whereabouts and state of individual products in the chain can empower procurers decision making in supply and waste handling decisions, knowing exactly when products are to be recovered, replaced, or disposed of. Although disposal are quite contrary to what CE is supposed to be, it is as explained in the critique section to be likely unavoidable in its entirety. However, tracing technology can at least enable efficient maximising of lifetime of the to-be-disposed products, opening the possibility of precise condition-based maintenance instead of regular time-based or even corrective maintenance.

For the canvas, this finding was considered to be most fitting as a procurement systems enabler. It can provide important data to base procurement decisions on, allowing procurement managers to source according to CE principles. It was also deemed to be highly relevant for the supply process. The technology may provide valuable data to enable procurers to optimise the purchase-to-pay process and material flows. Monczka's enabling processes (van Weele, 2018) also brings up the important of developing and implementing IT systems. There are also arguments to be made for the role of technology in the strategic sourcing process. However, as discovered in the specialisation project and described in the ProBiz4CE section, the establishment of such technologies can be considered to be extensive to implement. Therefore, the collaboration and commitment of suppliers is an antecedent for successful implementation and utilization. Should this technology become a standard among suppliers, it would become relevant to include it in the strategic sourcing process.

Information and communication technology

Information and communication technology (ICT) is a general term for any kind of technology that provides digital tools for information flow and communication between entities. Tracing technology is such a technology, but it was deemed interesting enough for circular procurement practises in its own right to separate it from its own finding. Information and communication technology as an aspect in procurement for CE may provide a plethora of benefits, as it is such a broad collection of different technologies. As presented in the section on technologically enabled procurement, Rejeb and Appolloni (2022) introduces many of the advanced technologies that may assist procurement in stimulating circular value chains such as the Internet of Things (IoT), artificial intelligence (AI), machine learning and big data analytics. As described, all of these technologies may lead to an increased effect of circular procurement. As will be elaborated upon in an upcoming section, collaboration has been identified as a crucial antecedent of CE and advanced technologies as blockchain. IoT-assisted technologies are believed to be a powerful facilitator for empowered collaboration, based on systems that provide unrestricted data flow and a unified interface between the actors of the value chain. The framework aims to emphasise how singular technological solutions may not be very effective on its own, but rather it can be realised in an interconnected system of technologies working together. This is built on findings from the specialisation project, especially based on prior research from Srari and Lorentz (2019) on inter-linkage between systems and design principles for technologies.

Information and communication technology (ICT) was placed in the same positions on the canvas as technology for supply chain transparency, but also included in the supplier management process. It being put into procurement system enabler follows the same reasoning as for technology for supply chain transparency; it provides data to be used in procurement processes. ICT can also provide the interface needed for collabor-

ative processes internally, such as production or sales, but also externally with suppliers and stakeholders (Zhang et al., 2016). When placing it on the canvas, the same reasoning is used to place it in the supply process. In this framework proposition, it is believed that supply chain traceability technology cannot be used without complementary information and communication technology if the aim is to stimulate circular value chains. This is substantiated by the findings of Zhang et al. (2016) in that the implementation of ICT itself would not necessarily positively impact supply chain performance. It is rather the way ICT is used and bundled together with other resources, such as coordinated and collaborative supply chain strategies, that creates performance advantages. Continuing, it is found that inter-organisational ICT can provide direct effects on supply chain performance. However, intra-organisational ICT does not have the same correlation, and it is unknown whether supply chain performance will improve (Zhang et al., 2016). Additionally, ICT is included in the supplier management process. The potential unrestricted information flow between the procurer and the supplier may be a powerful tool in joint development and collaborative processes. ICT can also affect supplier relationship management in managing the supplier network by creating databases with all relevant information on suppliers (Jääskeläinen & Hirn, 2016). Since information and communication technology is such a broad definition, one could probably argue that it can fit into some way any part of the canvas. It was, however, deemed sufficient to mostly limit its application to how it can empower collaborative processes.

Sourcing circular materials

Purchasing circular materials is a straightforward description of what procurement can do to directly stimulate circular value chains, following the principle of CE of circulating materials and products. Procurers should purchase materials that are capable of a longer lifetime and with circular economic principles in mind. Its inclusion in the canvas is because of how central it is for circular procurement at its core, but also how all other aspects of the canvas are in place to ultimately empower this activity. A proposition is that a committed organisation and procurement staff with a circular economy-based procurement strategy, with the assistance of advanced technologies, could see a greatly increased effect of circular procurement efforts.

Sourcing circular materials is put into the canvas as an procurement strategy enabler, as it should be deeply rooted into the strategy of the organization to commit to CE efforts. It is also placed in the strategic procurement process, acting as a direct consequence of the procurement strategy. Strategically procuring circular materials would involve conducting supplier selections based on CE criteria. Deciding on relevant and effective criteria is likely to be an extensive process in itself, and is also something that could be integrated into procurement processes. This is a process that could be enabled by the improved information flow and data provided by the advanced technologies mentioned above. Sourcing circular materials is closely tied to supplier management and supply as well, but it was deemed sufficient to look at the actual sourcing process of identifying and selecting suppliers.

Collaboration

Collaboration is a significant aspect of the framework and is expected to play a role on many levels and for multiple reasons in circular procurement. Developing and managing supplier relationships is a procurement process found in Monzcska's model (van Weele, 2018), along with supplier integration and development. These are processes that typically entail extensive collaboration for a common goal, such as developing new technologies or products. From a CE perspective, this can be a collaboration in the aim of introducing new circular materials into the value chain. There is also collaboration with waste handlers that can take traditional "waste" and turn it into something of value; however, this is not necessarily purely a procure-

ment process. Sustainable business models are another interesting case for collaboration, as explored by Witjes and Lozano (2016). PSS required closer collaboration than traditional business models, as product ownership changes and the supplier has an active role in maintaining product functionality. This will be elaborated upon further in an upcoming subsection about sustainable business models. Internally in organisations, there is also a case for the importance of collaboration, such as between procurement staff and between procurement and other business functions. This is reflected in the emphasis cross-functional teams and knowledge have on Monczka's enabling processes (van Weele, 2018). Stakeholders are also important collaboration partners, as their acceptance is paramount to viably conduct business.

In addition, collaboration plays a central role in the implementation and use of advanced technologies. One of the main findings of the specialisation project indicates how important collaboration between the participating actors in a technology is for a successful implementation. However, it was also found how tracing technology could change the perception of collaboration in procurement. Tracing technology, such as blockchain, is built on trust and collaboration, but it also generates trust and enables more extensive collaboration between actors.

Collaboration was found to fit into many parts of the canvas, but it cannot be understated how important it is for both procurement functions and advanced technologies as a whole. Collaboration is placed on the procurement staff and the procurement organisation enabler, as it is deemed as important at all organisational levels. Additionally, it is added to the supplier management process. Supplier collaboration is central for realising a change into sustainable business models, implementation of advanced technologies, and development of new sustainable products.

Knowledge, commitment and top management support

Knowledge, commitment and top management support are found to be important in the realisation of the effects of circular procurement efforts. Monczka's model of enabling procurement processes (van Weele, 2018) brings up the development and education of staff as important to realise procurement objectives efficiently and effectively. In the case of circular procurement and supplier selection, there is likely to be a drastic change in weighting criteria for selection, and procurers should be aware of the importance and effect of new "circular" criteria. As presented in the critiques of CE section, there is apparently a lot of confusion and uncertainty about what CE is in practise. It should be clear to procurement and the organisation as a whole what they are working toward with clearly defined objectives. This is where top management support becomes increasingly important. It is described that employees are more willing to commit to CE practise if targets, objectives, and practises are integrated into the organisational planning ((Klein et al., 2022)). Top management support is also described by Weele and Rozemeijer (2022) as an important enabler for procurement strategies. Knowledge, commitment and top management support is also found to be an important factor in many areas of the canvas. As an enabler, it fits appropriately into procurement strategy, procurement organisation, and procurement staff, but also is of great importance in the supplier management process. The development of supplier knowledge concerning CE could greatly benefit the procurers' organisation in stimulating circular value chains.

Sustainable business model

Sustainable business models are believed to be important in the transition to CE and may have consequences for procurement practises. Bocken et al. (2014) and Witjes and Lozano (2016) are some of many who emphasise how the development of new business models may be necessary to generate value in a sustainable

manner. PSS is a commonly cited type of sustainable business model, which changes the functional unit from the product itself to the use of the product (Witjes & Lozano, 2016). Procurement would be the contact point for suppliers where collaboration would be made in regards to the maintenance and functional restoration of the functional unit. Business models are such a fundamental part of what a business does, and this should reflect an organisations commitment to achieve circular efforts. Procurement strategies should be developed according to the business model to ensure that procurement practises are performed in order to achieve the set objectives. It should be noted that there are many different possibilities of sustainable (or circular) business models, and the development direction of these should be considered on a case-by-case basis (Bocken et al., 2014). Sustainable business model is placed within the procurement strategy and procurement organization enabler of the canvas. It is also placed in the strategic procurement process, reflecting the model developed by Witjes and Lozano (2016), emphasising collaboration between suppliers and procurers business models.

Objectives reflecting circular economy principles

An effective transition into a circular economy is described to require clearly defined organisational objectives reflecting the principles of CE (Klein et al., 2022). As described in the subsection about knowledge, commitment and top management support, employees are more likely to be willing in its efforts with clearly defined objectives. With clear goals and objectives, it is possible to monitor progress towards achievement of said goals. Procurement performance management is described by Weele and Rozemeijer (2022) as an enabler of achieving defined objectives. The development of valuable monitoring metrics could be enabled by the empowered information flow from advanced technologies.

Objectives reflecting circular economy principles are placed with the procurement performance management enabler in the canvas, as well as procurement objectives. The objectives are divided into three, illustrating the principles of CE; [1] Eliminate waste and pollution; [2] Circulate products and materials; and [3] Regenerate nature. These are just included as an example of how a business can define objectives with the aim of efficient CE efforts through procurement. The actual quantification of relevant objectives will vary on a case-by-case basis and procurement settings. There are many indicators that can be applied to monitor CE progress. OECD (Organisation for Economic Co-operation and Development) has created an inventory of indicators used between 2018-2020 (Ander, 2021). Typical environmental indicators could be energy efficiency, CO2 footprint, greenhouse gas reduction, repair and reuse of materials, virgin materials consumption and waste collection. However, CE also concerns social and economic sustainability, and progress toward these should not be ignored.

No.	Finding	Description	References
[A]	Technology for supply chain transparency	Enabling a transparent supply chain with the help of technology such as blockchain. Can provide valuable insight and information on products and materials in the value chain, which in turn provides decision support in procurement. A transparent supply chain may not only provide CE benefits, but also provide clarity in supply decisions, ensuring an efficient supply chain. Combination of enrichment [1] <i>Decision support whether to keep product in value chain</i> , [3] <i>Better data on amount and quality of product in value chain</i> and [5] <i>Decision support on when to send product for recycling</i> .	(Hastig & Sodhi, 2019; Khan, Razzaq et al., 2021; Khan, Zia-ul-haq et al., 2021; Kumar & Chopra, 2022; Rejeb & Appolloni, 2022; Srail & Lorentz, 2019; Xu et al., 2022)
[B]	Information and communication technology	Information systems for product/material data collection and storing, as well as performance reporting. Can authenticate material provenance and quality. Clarity on the material flow in the value chain can provide data for CE performance monitoring. Communication technologies which can communicate cross-system with suppliers and other relevant actors may also be an important enabler to ensure an efficient informational flow in the value chain. Combination of enrichment [1] <i>Decision support whether to keep product in value chain</i> , [2] <i>Easier retrieval</i> , [3] <i>Better data on amount and quality of product in value chain</i> , [5] <i>Decision support on when to send product for recycling</i> and [7] <i>Documentation on if product is adhering to regulations and policies</i> .	(Hastig & Sodhi, 2019; Khan, Razzaq et al., 2021; Khan, Zia-ul-haq et al., 2021; Kumar & Chopra, 2022; Rejeb & Appolloni, 2022; Srail & Lorentz, 2019; Xu et al., 2022)
[C]	Sourcing circular materials	Prolonging the life-cycle of products in the value chain. Circular materials refers to materials or products which in any way can be restored back to a usable state after original usage. Combination of [4] <i>Less output</i> , [6] <i>Higher value retainment</i> and [8] <i>Lowered required input</i> .	(Hastig & Sodhi, 2019; Khan, Razzaq et al., 2021; Khan, Zia-ul-haq et al., 2021; Kumar & Chopra, 2022; Srail & Lorentz, 2019; Xu et al., 2022)
[D]	Collaboration	Collaboration between actors of the value chain can be paramount to empower procurement in facilitating CE transformation. First of, collaboration between procurers and suppliers may be necessary to enable both new sustainable business models as well implementation of advanced technologies. Furthermore, there is collaboration with waste handlers and technology providers to deploy and utilize the necessary infrastructure for their core tasks. Internal collaboration between competency experts may also be beneficial for not only CE practice in procurement, but also in other functions of the organization. Finally, collaboration with stakeholders may also prove important to ensure acceptance from the ones with stakes in the business.	(Eisenreich et al., 2022; Rejeb & Appolloni, 2022; Witjes & Lozano, 2016)

Table 2: Part 1: Overview of theoretical findings.

No.	Finding	Description	References
[E]	Knowledge, commitment and top management support	Knowledgeable sustainability-minded procurement practitioners may have a positive effect on CE efforts. Firm infrastructure supporting CE transformation, with a top management support may be an antecedent for capturing the value of individual purchasers committing to CE. Clear targets, objectives and organisational planning towards the goals of CE may be crucial for enabling circular procurement. The procurement strategy should be a clear reflection of the goals set by the company, and a formalized planning process should be in place.	(Eisenreich et al., 2022; Klein et al., 2022; Neessen et al., 2021; Weele & Rozemeijer, 2022; Xu et al., 2022)
[F]	Sustainable business model	Moving away from the traditional buy, use and dispose model and adoption business models with circularity in mind may be necessary to realize CE efforts. There are a broad kind of business models proposed which may positively contribute to the transition of CE, which of many focuses on collaboration and leasing between supplier and procurer. Which sustainable business model to adopt will vary on a multitude of factors, and there are likely not a universal business model solution for all CE practices. PSS is however a prominently described model in sustainable business model literature. Procurement plays a central role in ensuring that a business operates accordingly to its business model by being responsible for sourcing and supply chain management.	(Alhola et al., 2019; Bocken et al., 2014; Mont, 2002; Witjes & Lozano, 2016)
[G]	Objectives reflecting circular economy principles	Translating the three circular economy principles into objectives for procurement: [G1] Eliminate waste and pollution, [G2] Circulate products and materials (Preserve them at highest value) and [G3] Regenerate nature. Supporting theory that practitioners should have clearly defined CE goals.	(MacArthur et al., 2015; Neessen et al., 2021)

Table 3: Part 2: Overview of theoretical findings.

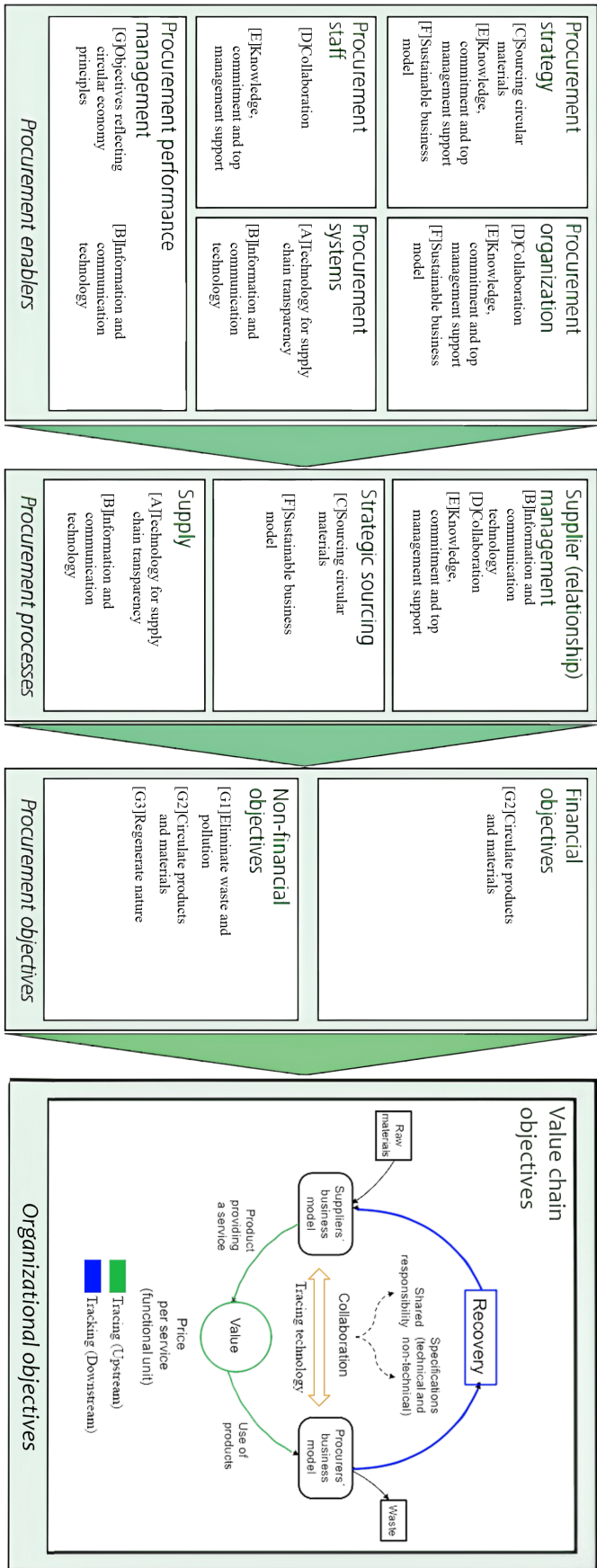


Figure 12: Thesis framework: Procurement canvas for CE.

3 Research Method

In this thesis a qualitative approach has been chosen to explore how technology-driven procurement can stimulate circular value chains. In this section, the methods used to gather the relevant data for the thesis will be presented. As stated previously, the purpose of this research is to explore the real-world applicability of the findings from the thesis framework, both novel and findings from the specialisation project. To explore this, a qualitative method has been chosen, with the use of in-depth interviews as the main source of data collection. In addition a narrative literature review with an emphasis on procurement, procurement strategy, and the circular economy is conducted to discover new findings that could enrich the thesis framework.

3.1 Research design

Clark et al. (2021) explains that research design is the framework for data collection and analysis. The research design of this thesis is a case study. This allows an in-depth examination of the case (Yin, 2018), where the scope of the study is the actors within POCoplast, which are producers of industrial plastic waste and consumers of recycled plastic. Since this thesis pertains to the aquaculture industry, the main weighting has been placed on Grieg Seafood.

The inclusion of the other actor Flokk, a furniture manufacturer, in addition to Grieg Seafood itself, was done to expand the basis for data, thus increasing the external validity. This need for expansion was discovered during the course of this thesis, as the acquired basis for the data was found to be not necessarily adequate. The inclusion of Flokk has been deemed appropriate for this thesis, as both Grieg Seafood and Flokk are participating in POCoplast and are producers of industrial plastic waste, and are consumers of recycled plastic to various degrees. Flokk is currently not purchasing any recycled plastic from aquaculture actors such as Grieg Seafood, but their interest is to explore this opportunity. Recalling figure 1 that illustrates a conceptual value aquaculture value chain for plastics, Flokk is an outside actor interested in an increased supply of recycled plastics.

As the objective of this thesis is to explore procurement, and the use of technology in the function, in a given organisation and value chain, it easily lends itself to the use of a case study (Tjora, 2021). Yin (2018) also describes that the use of a case study is applicable when the research questions pertain to the questions of how and why. With the goal of this thesis being to explore how technology-driven procurement can stimulate the circular economy, it has thus been deemed that the research method is appropriate for this purpose. Furthermore, in that the research of procurement efforts and CE in combination represents a fairly novel research area, the use of a case study approach is therefore deemed appropriate. By considering the scope of the study to include actors within POCoplast that produce plastic waste and consume recycled plastic, this can be considered as an embedded case study. This allows both companies to be considered sub-units of a larger case, and could then be classified as an embedded case study (Yin, 2018). There is, however, a significant weighting on Grieg Seafood as opposed to Flokk, seen especially with the amount of interview subjects. As the problem statement describes, it is the potential of a technology-driven procurement strategy to stimulate the circular economy in the aquaculture industry that is of interest to explore. Flokk is thus used as an instrument to reflect and mirror some of the findings from Grieg Seafood. As stated previously, this is deemed appropriate as they share the same interest and some of the same prerequisites by being in the same group of stakeholders in post-consumer plastic.

The thesis framework as described in the previous section will act as a theoretical lens for this thesis. The use of this framework allows us to analyse the findings systematically and to see them in the context of the

theory. This framework was designed by using the procurement canvas by Weele and Rozemeijer (2022) and further enhancing it with theoretical findings from both a narrative literature review and the findings from the specialisation project. This allows the findings of this thesis to be analysed in the context of the framework. This then makes it possible to validate the enriched ProBiz4CE framework and to explore whether the model actually reflects the potential a technology-driven procurement strategy can have in stimulating a circular value chain. This is done by exploring how representatives from the organisation view and reflect on the principles described in the literature. Additionally, by contrasting the interview data with theoretical insights, a result can be achieved on the potential of whether a technologically driven procurement strategy can stimulate the circular economy. In exploring this potential, we will examine how procurement efforts in the present time function in stimulating CE, and then how technological tools can further enhance and improve these efforts.

As stated previously, while the main organisation to be studied in this thesis is Grieg Seafood, another actor, Flokk, has been added. While this is deemed to increase external validity, by increasing the basis for the data, and thus making the findings more generalisable, there are some consequences for the thesis. The addition of another company to the case study can possibly create confusion, especially when the results are presented. This confusion can originate from which company is saying what, and also can contribute to reducing the coherence of the results section. This is mitigated by clearly stating when the opinions from Flokk are described. Additionally, the statements from Flokk are presented to support the findings of Grieg Seafood.

This research design has some implications for the replicability of the study. Inherent in qualitative studies is the problem of what the researchers choose to emphasise, and that it often relies upon the researchers' ingenuity (Clark et al., 2021). Continuing, Clark et al. (2021) also points out that the responses of the participants are affected by the characteristics of the researchers. As well as with the unstructured data, a qualitative study will be influenced by the subjective decisions made by the researchers. However, these flaws are considered and an effort is made to document decisions relating to research design. This would then mitigate the negative effects of this qualitative study.

3.2 Interviews

In this thesis the main method for data collection are semi-structured interviews. This method allows for the addressing of specific topics, and is suitable since the thesis has a clear focus and is qualitative (Clark et al. 2021). The use of interviews further allows for the interviewees to firstly describe their operations and thoughts about them, and secondly to share their sentiment and perception of technological innovations in the procurement department. This enhances the validity of the study, where there is a clear link between the subject being studied and the methods being used (Tjora, 2021). The choice of case and interviewees further enhances the external validity, since it is deemed that the organisation and workers within reflects the sentiment of similar workers within different industries.

Interview guide

In that the data gathering will utilise semi-structured interviews, the creation of an interview guide was necessary. This is to properly and systematically admit questions that properly reflect the nature of the thesis. Additionally, an interview guide gives a framework for the interview, covering the required topics, while still allowing for in-depth descriptions by the interviewees (Clark et al., 2021). A point of consideration was to formulate the questions so as to give the informants the possibility to give responses that could be used to

find answers to the research question. This was achieved using the problem statement, including the research questions, to formulate questions intended to direct the informants to the corresponding topic. Questions were designated into categories based on the topic covered, with the categories intended to encompass the relevant topics included in the problem statement.

The categories pertained to the topics of background, current situation, circular economy, use of technology in procurement, desired effects, and conclusively. The category of background was added for contextual reasons, providing information on the background of the interviewee. Additionally, it had the added effect of acting as an introduction to the interview, and thus allows the interviewees to become comfortable with both the format and the interviewers (Tjora, 2021).

The second category, current situation, was added to provide information on the operations of the organisation and allows the interviewees to provide information related to research question 1. Interview questions pertaining to the circular economy, the use of technology in procurement, as well as the desired effects, were added to allow the interviewees to answer the views of the corresponding topics. On the basis of these answers, an analysis of the potential of technology-driven procurement for stimulating the circular economy is presented. Lastly, questions in the category conclusively give the opportunity of the interviewees to add information of their own accord. In addition, the opportunity to propose future interview candidates was provided.

The questions were designed to be open ended, this to allow for the informants to reflect on the question and subsequently to engage in in-depth answers. The interview guide was designed to allow for sufficient responses, while not being too protracted. The length of the interviews was aimed at not exceeding one hour, aiming at 45 minutes. This is done to reduce the chance of fatigue of interviewees and as an act of courtesy out of respect for the attendants time (Tjora, 2021). The questions were formulated beforehand to ensure validity, so that the same formulations were used for all interviewees. However, as the interviews were semi-structured, the order in which the questions were asked varied, based on the answers provided.

Recruiting

To achieve a valid result in a case study, it depends on the recruitment of informants who can make a statement on the topic being discussed (Tjora, 2021). In this thesis, the recruitment method is mostly based on snowball sampling. This method consists of establishing contact with a small group of people and using them to connect us with future potential candidates (Clark et al., 2021). In this case, Grieg Seafood employees who know POCOplast serve as the initial entry for snowball sampling. This method is classified as purpose sampling, where the selection is done deliberately from information-rich samples, making it possible to obtain data to answer the research questions in a focused and informative way (Clark et al., 2021).

To increase the chances of successful recruitment of informants for the thesis, the thesis was advertised in a monthly gathering for the SINTEF research project POCOplast. In this meeting, the specialisation project was presented, in addition to the problem statement and general direction for this thesis. Then this opportunity was taken to make it easier to recruit interview subjects. In that contact already was established with the initial informant of Grieg Seafood, the effect of this is uncertain, but that Flokk accepted the proposal for joining this project may have originated from this.

The alternative of probability sampling has been deemed not necessarily useful in this thesis, as the research consists of exploring a set problem in a defined field. This then makes the benefit of generalisation based

on statistical representation of a lesser value than that of purposive sampling (Clark et al., 2021).

Coding

To properly assess the findings of the interviews, it was chosen to code the interviews. Tjora (2021) describes three main reasons for why this should be done: Extract the essence of the empirical material, reduce the volume of the material, and lastly facilitate the generation of ideas connected to details in the empirical data. The coding was created to be as close to the empirical material as possible while using "native" terms and phrases. In doing this, the risk of the findings being influenced by the expectations and theories of the researchers will be reduced (Tjora, 2021). Further, the coding was then categorised inductively, based on the subject discussed. These code groups can help to structure the data and can provide a direction for the analysis (Tjora, 2021).

Case description

Table 4 contains the final overview of the interviewees. Following is a description of each interviewee and their position at the companies. Additionally, a brief introduction to the companies is presented.

Interviewee	Company	Position	Interview length
Interview subject 1	Grieg Seafood	Global sustainability advisor	40m 55s
Interview subject 2	Grieg Seafood	Procurement manager	34m 21s
Interview subject 3	Grieg Seafood (Regional office)	Purchasing manager	53m 20s
Interview subject 4	Flokk	Chief design officer	41m 49s

Table 4: Overview of interview subjects.

Interview subject 1: The position of interview subject 1 at Grieg Seafood is global sustainability advisor. The subject has been in this position since 2020. In this role, the subject works with strategic improvements, planning, and reporting. Included in this position is the responsibility of being updated on movements within the field of sustainability in aquaculture, by reading research papers, news letters, and industry publications. This also includes being updated on recycling, plastics, and developments within the circular economy. This position has a global outreach, being responsible for the sustainable operations for all of Grieg Seafood's locations.

Interview subject 2: The second interview subject has the position of procurement manager at Grieg Seafood, which entails global responsibility of all procurement except fish feed. This is estimated at a procurement value of 2 billion NOK. The subject has been in the position for 6 years. The subject is not hands-on with every procurement decision. Grieg Seafood is split into 4 regions, two in Norway and two in Canada, which results in a lot of regional procurement. The main tasks of the procurement manager are to coordinate the procurement and design the procurement strategy and policy. The procurement manager is also responsible of keeping their code of conduct for suppliers up-to-date and to ensure that each region is compliant accordingly. In the cases of cross-regional procurement, the procurement manager is usually in an active role in conducting the process. This is typically large products such as manufacturing equipment and fish cages. Otherwise, the procurement manager is a competency resource for local procurement decisions.

Interview subject 3: Subject three has the position of purchasing manager for one of Grieg Seafood's locations. The subject has been in this position for 10 years. The responsibilities for this role include maintaining the framework for the purchasing function, including tendering, negotiation, following up suppliers, as well as daily follow-up of the internal affairs in the function. Included in these daily responsibilities is the act of discovering synergies in the purchase of materials and services of the operation of the fish-farm. Moreover, the purchasing manager has the responsibility of coordinating materiel, exploring whether it could be reallocated, or if new materiel needs to be acquired.

Interview subject 4: The fourth subject is the chief design officer at furniture manufacturer Flokk. The subject is part of the executive committee and has full responsibility of brand architecture, product development, and sustainability. The subject has been in the position for about 16 years and in the executive committee for 14 years. This role entails leading 58 engineers and designers in 4 countries.

The company introductions will give a brief overview of their history, business operations, and some insight into their sustainability development and focus. Descriptions are based on information from company websites and recent annual reports.

Grieg Seafood is an international salmon farming company with farms in Rogaland and Finnmark in Norway and British Columbia and Newfoundland in Canada. 82000 tonnes of fish harvested in 2019 make Grieg Seafood one of the largest actors in the fish farming industry (Grieg Seafood, 2020b). Grieg Seafood employs almost 800 people in their regions, with its headquarters located in Bergen, Norway. Grieg Seafood is renowned for its commitment to sustainable practises, participating in multiple partnerships and collaborative research projects with the aim of sustainable development of the industry (Grieg Seafood, 2020a). They strive to ensure that local communities, customers, and civil society can trust that they operate responsibly and according to high standards, which is reflected in their commitment to certify all of their farms with the ACS-standard by 2023 (Grieg Seafood, 2020c). The Aquaculture Stewardship Council (ASC) is a rigorous certification for farmed salmon, which criteria include assessments on biodiversity, pollution, diseases, feed, and social aspects.

Grieg Seafood has put an increasing emphasis on achieving greater transparency in their supply chain and year-by-year demands better information on what they source (Grieg Seafood, 2022). In their 2022 annual report, Grieg Seafood illustrated their five pillars of focus and material topics aligned with the Sustainable Development Goals. A snippet of this illustration is seen in figure 13. Plastic pollution is identified as one of their material topics, to which they paid great attention in their annual report for 2021 (Grieg Seafood, 2021). After a detailed impact assessment and comparison to other material topics, it was omitted from the 2022 report. The report still emphasises the importance of the plastic pollution problem (Grieg Seafood, 2022).



Figure 13: Grieg Seafood’s five pillars (Grieg Seafood, 2022).

Flokk is a leading furniture manufacturer in Europe, specialising in office chairs. The Flokk organisation consists of ten brands, with production sites in Norway, Sweden, the United States, the UK and Poland (Flokk, 2023a). Their flagship brand, HÅG, is produced in Røros, Norway. Long-term commitment and comprehensive sustainability focus aims to position Flokk amongst the top tier within the area of ESG (Flokk, 2022). Other brands under the Flokk umbrella include RH, Giroflex, Offecct, RBM, BMA, Malmstolen, Profim, 9to5 and Connection. Flokk is proud of their structured focus on environmental sustainability over 40 years, with aspirations to be conscious market leaders (Flokk, 2023b). Flokk is also dedicated to exploring opportunities in a circular economy and is working on solutions to encourage responsible consumption and reuse after first use (Flokk, 2021). This is a recurrent design principle in their chairs, using recycled and recyclable materials when possible, while still providing premium engineering and durability. Timeless design is also an important principle in their design, aiming to make consumers want to continue using their chair indefinitely (Flokk, 2022). In their exploration of circular business models, Flokk has identified furniture-as-a-service and buy-back offerings as emerging opportunities. Already in 1993 Flokk defined five circular design criteria, which still stand valid as of 2022. These circular design criteria are illustrated in figure 14, with accompanying focus areas. The Flokk group employs 1796 FTE’s as of the end of 2022 (Flokk, 2022).

5 CIRCULAR DESIGN CRITERIA

1. **Low weight**

weight optimisation – resource efficient solutions – lower transportation costs – easy handling

2. **Few components**

integrated functions – modularity – fewer tools – less processes – simpler assembly – less packaging, storage, and transportation

3. **Right choice of materials**

no harmful chemicals and substances – increased use of recycled and renewable materials – use of recyclable materials

4. **Long life span**

lasting & durable designs – high quality – easy replacement of worn-out or broken parts – reduce the need to replace our chairs – circular economy: maintain, reuse, refurbish

5. **Design for disassembly**

no glues, staples or non-accessible screws – simple dismantling with commonly available tools – easy to sort materials for recycling with marked parts – keep materials in closed loop



3(III) FOCUS AREAS

I. **Climate** – reduced carbon footprint and energy consumption

II. **Resources** – reduced use of materials and minimised waste

III. **Health** – reduced chemical use and no hazardous substances

Figure 14: Circular design criteria for Flokk (Flokk, 2022).

3.3 Literature review

In addition to the qualitative elements of this study, a theoretical part is also included. This is to give a sufficient context of the topic. In addition, the theory admitted allows for an analysis of the findings based on theoretical concepts and consensus. To explore the literature, a narrative literature review was performed. This made it possible to admit relevant literature, without the constraints a structured literature review would entail. The search was carried out by searching in SCOPUS and Google Scholar. The search terms used include "circular procurement"; "circular economy AND procurement"; "CE"; "Collaboration"; "blockchain AND procurement"; "Blockchain and CE". In addition to this search, a snowball method was used, where relevant authors described in prior literature were explored and admitted if deemed relevant. This method is then used until it is deemed that all relevant concepts are sufficiently described and the required context is provided. By using this method, the literature search develops organically, and has the positive effect of not being overly time-consuming, while allowing for flexibility. The snowball sampling method does, however, have the drawback that the admittance of literature relies on the researcher to uncover interesting topics and authors. This can have the consequence that relevant research papers that would otherwise be admitted are not. However, the risk is not deemed unacceptable, as the research papers and authors admitted still present a valid context and background to be used in this thesis.

4 Empirical results

In this section the results of the interviews will be presented. These results were obtained with the use of the methods presented in section 3. In this section, the data will be presented in a way that eases the understanding, including both paraphrases and direct quotes. All of these are based on the transcriptions of the interviews. The results will be presented in a categorised form. These categories are correlated with each topic in the interview guide. This is to ensure that the results are presented in an organised and legible manner. As stated in section three the category of background is added to present the context of each participant. In this, the role of the participants and their daily activities are described. In the category of *procurement strategy and current operations* the state of the organisation, and how activities are performed in present time will be presented. In the category *circular economy* results pertaining to activities and attitudes towards the circular economy will be shown. Similarly, in the subsection *use of technology in procurement*, current efforts in the use of technology will be displayed, including experiences and perception of the topic. Additionally, the desired effects, the workers and organisations perception towards the discussed elements will be noted.

4.1 Procurement strategy and current operations

Grieg Seafood's procurement strategy is described by the Procurement manager (2023) as performing the procurement activity to attain products with the right quality at the right price. Continuing, to maintain transparency within the organisation, a procurement policy has been devised, where all purchases which exceed 500.000 NOK are tendered. Although this act is not required by law, since Grieg Seafood is a private company, it is done to foster competition and ensure fairness. The points by which the suppliers are evaluated are price, quality, location, and, in recent times, sustainability. The inclusion of the point of environmental sustainability as a competitive point is stated to be a recent development, having been the focus of attention over the last five years (Procurement manager, 2023).

A code of conduct for suppliers is maintained so that Grieg Seafood has a consequent strategy in which they operate toward their suppliers. In this document various requirements towards their suppliers are noted. These can include supplier policies on corruption, child labour, and compliance with the transparency act, among others (Global sustainability advisor, 2023). The Purchasing manager (2023) states that this code of conduct is known at the operational level as well, although the level of knowledge is not copious. However, the principles of this code of conduct are adhered to, with the environmental and local implications of various purchases being considered:

”We have, as a company, committed ourselves to sustainability goals that concern both the environment and local implications. At the same time, we have to operate both efficiently and economically, so there are a lot of considerations that have to be made in our purchases.” (Purchasing manager, 2023).

This balancing is also described by the Procurement manager; on supplier selection it is quoted:

”There is a balancing act we have to consider at all times, we have different criteria that we evaluate by, such as price and quality, but we also consider local presence. And lately sustainability has become an important presence in purchasing” (Procurement manager, 2023).

It is explained further that suppliers are also asked to provide a sustainability account; whether they have a sustainability goal; whether products and components are circular; and others (Procurement manager, 2023). The Global sustainability advisor (2023) states that one of the key strategies to secure supply is to have solid framework agreements, mostly on goods that are essential for operations. These framework agreements are often shared between locations in the same country. In further detail, it is stated that each of these four locations has its own purchasing manager who performs the purchasing activity for their individual region (Global sustainability advisor, 2023).

Comparatively, the procurement strategy at Flokk also concerns the use of framework agreements, where a single supplier provides their post-consumer plastic requirements, in which all their injection moulding functions calls off from; "We have the deal, we have defined the quality based on their [waste handlers] capabilities and ability to sort and access to waste, et cetera." (Chief design officer, 2023). Further, it is explained that the next focus area is that of knowing the provenance of the materials and what the materials were in the last instance.

The reduction in the use of new products and thus the reuse of existing ones is a core element of CE (Okorie et al., 2018). In this regard, Purchasing manager describes that their philosophy toward the reuse of components is to operate them for as long as is appropriate and that it is better to use and maintain 50% of the equipment capacity rather than buying a new product (Purchasing manager, 2023). Continuing, it is described that this requires re-certification based on the standard NS-9415. The current version of the standard has been identified as a challenging factor in the reuse of components.

"Now it is harder, with revised NS-9415, you will not get further re-certification. You can get 5 years for some [elements of the product] and 2 years for something else. It is challenging, and it is a little counter intuitive, because it is extra effort in extending the life time of the products." (Purchasing manager, 2023)

It is further stated that it would be easier, and more cost effective to buy new products rather than re-certifying them, but re-certification is still done as it is seen as the right thing to do. One of the strategies mentioned to prolong the lifetime of the components is to purposively order overdimensioned products to ensure that the equipment passes the re-certification tests (Purchasing manager, 2023). Another stated strategy used to increase lifetime is that of modifying older equipment along with the suppliers:

"On fish pens, we have found a size that is good for us, but technology development has been good. We have what we bought 12 years ago and now it is outdated. Together with our suppliers, we look at whether we can weld in, modify [the fish pen], so that we can get it re-certified. Like Akva group, they have done so that we could use fish pens that were originally too small for today's use, but which still had more lifetime left." (Purchasing manager, 2023)

Continuing on the re-certification of products, the Global sustainability advisor supports this by stating that there are projects which concerns the re-classification and re-certification of products. Moreover, it is added that there are individual strategies regarding re-certification, based on the product groups. It is stated that Grieg Seafood considers the opportunities for this based on opportunities, costs, and mostly common sense.

There has been a change in how Grieg Seafood treats end of life equipment:

"Previously these fish pens were given away to farmers or cabin owners, which churned it up

themselves and made floats and et. cetera. Today, the industry has become too big for this. We cannot give this away [anymore].” (Global sustainability advisor, 2023)

In addition to the economical aspect of the donation of end of life products, there are environmental considerations as well. The Purchasing manager describes that these products could possibly have a use in the private market, but most often end up as waste in the front yard of the recipient.

In terms of challenges with respect to the current operation, various elements were mentioned. Access to information and specifications is stated by Procurement manager as crucial when in the contracting phase. There is, however, often a problem in acquiring information relating to specific products:

”It is always a struggle to acquire [information], sadly. (...) [The suppliers] often have the fear that this would be distributed to others, even though we have contracts that stipulate that it will not be shared.” (Global sustainability advisor, 2023).

Moreover, current certification schemes for products are perceived as insufficient as a result of the increase in the need for product data. The supplier’s reluctance to share data is stated as a phenomenon that can make it harder for Grieg Seafood to correctly report in its sustainability accounting (Global sustainability advisor, 2023). The complexities of the supply chain are also mentioned as a challenge when it comes to purchasing sustainable goods and materials. It is stated that the change of suppliers due to geo-political situations can contribute negatively towards Grieg Seafood’s sustainable accounting. It is further exacerbated by the lack of data on the provenance and environmental impact of these new goods;

”It takes some time to get these data from our suppliers. Even though it is we that pay for this, it is our data. And they state that this is something we should have access to, but it is going slow, it does”. (Global sustainability advisor, 2023).

The rapid pace of technology innovations was also mentioned as a possible challenging point, especially when creating sustainable criteria for products with long lead times;

”Recently we entered negotiations on a vessel, in 2019, and drawn in 2020. At that time it was still early considering battery-power, hybridization. So when we drafted the contract, which runs until 2024, we notified them that next time we won’t buy this, next time we need one powered by battery or hybrid.” (Purchasing manager, 2023).

This exemplifies that the purchasing department has to be ahead when it comes to sustainable criteria, and to challenge their suppliers (Purchasing manager, 2023).

Continuing, on the effects that the procurement function has in stimulating CE, market pull is mentioned (Purchasing manager, 2023). It is stated that the purchasers have to use their buying power to create requirements which mirror the sustainable criteria, while also adding sustainability as a competitive point. This view is also shared by Global sustainability advisor, adding to this it is stated that for recycling to be profitable, it requires a market pull for recycled plastic. Furthermore, it is stated that the only market pull that is large enough is the industrial sector itself (Global sustainability advisor, 2023).

4.2 Circular economy

Knowledge about the principles concerning the circular economy appears to be strong in the organisation. The Global sustainability advisor (2023) is probably the interview subject to be the most exposed to the concept of CE, thanks to their position at the company. When asked about how they personally view the circular economy, Global sustainability advisor immediately brings up the 9R's framework ("refuse", "rethink", "reduce", "reuse", "repair", "refurbish", "remanufacture", "repurpose", "recycle" and "recover"; Okorie et al., 2018), displaying academic knowledge on the subject matter. Continuing on the topic of circular economy, the Procurement manager (2023) views CE as the circulation of products made up of materials that have had a prolonged life with reuse. This view is shared by the Purchasing manager, where an emphasis was put on the recycling and reuse of products. In addition, when questioned on personal experiences concerning the circular economy, consumer behavior is mentioned:

"Products are not maintained anymore, you just replace them, for my part I think that it is enjoyable to maintain products longer than their expected lifespan. (Purchasing manager, 2023).

In describing the concept to other industry actors, the Global sustainability advisor expressed an uncertainty on how to present and discuss the concept of CE. This, it is stated, is due to how various actors may have differing conceptions on the topic. This might indicate that there is a lack of industry consensus, as the Global sustainability advisor explains that the concept of CE is still nascent, and lacks an unambiguous definition in the aquaculture industry. However, some of the concepts of the circular economy are explained as being inherent in the aquaculture industry, exemplified by the Global sustainability advisor:

"If you go to a fish reception facility and ask the people working there about circular economy then they won't know what you are talking about. However, if you ask them whether they keep the blood and the entrails from the fish, they will answer yes, we have always done that". (Global sustainability advisor, 2023)

It is thus stated that it might be easy to forget that some of the concepts of the circular economy are already in place and are apparent. (Global sustainability advisor, 2023).

Parallely, when asked about the circular economy, the Chief design officer at Flokk describes two aspects of CE; circular business models and circular resource use. The subject believes that there is an imbalance of attention given between the aspects;

"There is a tendency, especially in our time, to get lost in the circular business model and think that this solves anything by itself. (...) It only solves something if it entails a longer lifetime for the product" (Chief design officer, 2023).

The Chief design officer (2023) experiences that there are many factors that can lead to products having increased lifetime, such as excellent product design or modularity that allows consumers to adjust products according to new requirements. This in turn is believed to increase second-hand value, and thus increasing overall lifetime of the product. The subject continues by stating that Flokk has to facilitate all of these factors leading to an extended product lifetime which adds value for the consumers. It is also emphasised that this has to be solved while being as resource efficient as possible, namely, avoiding the use of virgin material as long as it is possible to use recycled plastic, as well as designing products with recycled materials in mind.

Regarding Grieg Seafood's contribution to CE, the Procurement manager (2023) identifies a growing trend in the industry to participate in CE efforts and states that Grieg Seafood is committed to participating in this change. Grieg Seafood's role in the change into the circular economy is further supported by the Global sustainability advisor, where the emphasis is placed on Grieg Seafood's role as an ambassador for CE, both as an internal facilitator and as a challenger to their suppliers. It is further explained that Grieg Seafood works extensively according to the principles of CE and that the principles of CE have a significant weighting at the company (Global sustainability advisor, 2023; Purchasing manager, 2023). This is in some cases to the detriment of economical sustainability;

"In the later years we have emphasized it, and we have in some ways let a couple of [CE] principles surpass some economic principles. We have a belief that this is the right thing to do, and then we have let it affect some costs" (Global sustainability advisor, 2023).

This aspect of prioritizing CE principles over costs is also mentioned by the Purchasing manager. It is stated that during the specification of various products, if the recyclable variants are more expensive than the non-recyclable version, Grieg Seafood would rather take the more expensive variant, as it is seen as their responsibility until they find, together with their supplier, a variant that satisfies all requirements and still adheres to the CE principles (Purchasing manager, 2023).

The notion that environmental sustainability should also contribute to competitiveness is described as a key to success (Procurement manager, 2023). Continuing, the role of procurement in this is described as involving its suppliers to produce more and more sustainable products, which in turn increases competitiveness (Procurement manager, 2023). One specific factor that could contribute to competitiveness is reputation, since Grieg Seafood could use the fact that it is an environmentally friendly producer of farmed salmon and thus becoming a preferred supplier for their customers (Procurement manager, 2023; Purchasing manager, 2023). Moreover, that this strategy of being environmentally friendly is propagated throughout the company, from production to top management, is described as having value in and of itself (Purchasing manager, 2023). This point of finding a competitive advantage and finding a market group with a higher willingness to pay is also mirrored by the Chief design officer at Flokk. Furthermore, another aspect of this advantage is the early mover advantage, in that relations with the best suppliers that provide recycled raw materials can be established, thus securing the supply of these goods (Chief design officer, 2023). The Chief design officer describes the process in finding recycled material in an untapped market:

"We are always on the hunt for waste fractions no one has taken hold of. In a research project we had [regarding reuse of snow poles], we stumbled upon this waste fraction, and made 200 chairs, because that was what we had material for. We thought that this would be a good story to tell, and create attention and publicity around using trash to make quality furniture. After 2 days Statens Vegvesen called and said: "This is awesome, we want to join". After 2 more days Våler Vekst called and said that there is more of this [material] than you think. It is a waste fraction of 190 tonnes per year, the ruined snow poles, which are so broken that they cannot be placed out again in the fall. It is 190 tonnes per year in Norway alone which goes to waste incineration." (Chief design officer, 2023).

Sometimes, it is experienced that it is hard to defend some of these circular procurement decisions, exemplified by cost of ownership or life cycle costing considerations. Grieg Seafood has not developed criteria for these types of considerations, but is left to the discretion of the suppliers. Furthermore, there is no overview of how frequently sustainable criteria are applied, this due to the varied nature of products purchased;

”We buy many different products, services, and goods, so it is difficult to create universal criteria. Because of this we have such a broad procurement policy that states that we evaluate the relevant metrics for each process, and create relevant criteria on a case by case basis.” (Procurement manager, 2023).

Grieg Seafood is, however, open to the development of a more detailed and universal procurement policy for CE as they develop more knowledge on the concept of CE (Procurement manager, 2023). The subject suggests that a more concrete guideline or framework, localised to the various regions they operate in, might make Grieg Seafood better at performing circular procurement.

On the topic of challenges concerning the circular economy, the Global sustainability advisor (2023) states that the largest issue for Grieg Seafood’s current practises is tied the provability of effect;

”If you buy a product with a high quality, then it has a long lifetime. And then it is with the promise that you can recycle it after the useful life is over. Then let us say that the product has a lifespan of twelve years, and you bought it last year, then you still have to wait eleven years before you know whether it can be recycled as advertised. (...) I still have a lot of spreadsheets where I lack a lot of data, because the data are four years away.” (Global sustainability advisor, 2023).

The Purchasing manager (2023) supports this by describing that there are some products on which Grieg Seafood is reliant, due to matters of product quality and durability, which they do not know whether can be recycled or not.

The Global sustainability advisor (2023) continues by emphasising that this lack of data on CE, and sustainability efforts in general, makes it difficult to monitor the effects of these actions. With more data it is stated that it would be possible to create KPI’s in which one could measure and manage these effects, such as input, output, resource utilisation (Global sustainability advisor, 2023). Tangentially, the Chief design officer at Flokk describes a way data like this can be used to create KPI’s:

”I stumbled upon an example from Feiring Bruk, they deliver asphalt. They had an elegant way of doing it, they said that asphalt is bought per tonne. And every supplier that delivers must provide data that show the climate footprint in kg of CO₂ per tonne. And after that an internal carbon fee is applied to the various contenders, where it is applied that each kilogramme of CO₂ is worth a corresponding amount. Then the lowest value from the contenders was applied to the other suppliers, and ”punished” accordingly. This was a simple and transparent way to do this.” (Chief design officer, 2023)

Further on challenges regarding the circular economy, a lack of verifiable data on whether the circular products are of the same quality as the products made of virgin materials is also stated as being a challenge of circular procurement;

”I remember specifically when we were buying the net pens for the first time, then it was an uncertainty whether the [recycled] products would have as good of a lifespan [as the virgin variant]. We have to produce the fish and the products have to be of the same quality, but it worked very well.” (Procurement manager, 2023).

Continuing on the challenges, the cost of recycled materials compared to virgin ones were mentioned, as well as instances where the recycled variants did not exist yet (Procurement manager, 2023). The Procurement manager (2023) also explains the challenge with respect to the price. It is seen that recycled products are often significantly more expensive, or moreover that they do not exist yet. Furthermore, Purchasing manager (2023) explains that a challenge in sustainable actions is found in collaboration with suppliers;

”I tried to establish a record of materials in 2018-2019. We wanted to have control on what plastic based materials we had deployed at sea, from the various large suppliers. Some [suppliers] took it very seriously and sent reports unprompted, while others did not think it was as fun to do. I had to send reminders for four or five months to complete our records.” (Purchasing manager, 2023).

However, the Purchasing manager (2023) believes the task of circular procurement has become easier over the years and that the suppliers have gradually accepted the concept.

The Chief design officer (2023) brings up a story on challenges in circular procurement. In collaboration with TOMRA (invented reverse vending machines for returns of used plastic bottles), Flokk sourced recycled plastics from bottle caps to use as a fraction in their office chairs.

”(...) Then this was a success, and then we collaborated with TOMRA so that they could get this fraction, and then we needed more. We procured more of this fraction from a German waste handler and this was stable and quite good, and then suddenly we started having breakages in our product. And when this breakage came, there was only one thing to do, and that was to go back to virgin materials. What happened was that this waste handler had several facilities and there had been a fire in one of these. The materials were then funnelled through another facility with some other capabilities and a somewhat different incoming waste fraction. That was one of the contributing factors; the other was that our engineering was more on the knife-edge than we thought. So, we had no overview of the properties, provenance, and manufacturing locations of this, only the supplier and the legal factor. The result was that it put us back to start, and we had to start over.” (Chief design officer, 2023).

The story concluded with that Flokk had to revert back to close supplier collaboration, with framework agreements, with only a few suppliers, so that quality of product and provenance was assured. It is told that this framework agreement is still in effect.

4.3 Use of technology in procurement and effects

The use of technology in Grieg Seafood is currently restricted to the use of traditional IT solutions. However, it is identified that Grieg Seafood has potential for improvement on this front;

”I would say that we have a lot of room for improvement. We don’t use that much technology. There are still a lot of manual processes, there is a lot of excel, and e-mail.” (Procurement manager, 2023).

The Global sustainability advisor has similar views, in which the lack of advanced digital solutions is seen as a barrier and something that Grieg Seafood should explore further. Information and communication

technologies, such as an ERP system was specifically mentioned in regard to attaining and categorizing information;

”We have discussed whether we should [acquire] ERP systems. There is a lot of good data available out there, and there are many good solutions, but we do not have a complete overview over all these aspects yet. We see that we are getting more and more requirements from stakeholders to have control of this [data]. Before we could take these requests as-is; if you got a request [for information] from [a stakeholder] on the [sustainability properties] of our feed, we could take these issues with the various relevant suppliers. Now we see that we don’t have enough resources and capacity for this to the same degree. We get a lot of questions on a lot of varying areas, so we are drowning in these kinds of request.” (Global sustainability advisor, 2023))

Comparatively, at Flokk, the use of technology in procurement is at the same level (Chief design officer, 2023). This is exemplified by when the question on use of technology in procurement was asked; ”That is very simple, we don’t. (...) It is the same spreadsheets, the same methods, that one saw in the car industry 10-15 years ago.” (Chief design officer, 2023).

Although the use of advanced technological solutions is lacking, the prevailing attitude of Grieg Seafood towards technology seems to be positive;

”We are adaptable. We have always liked to pursue and test out new things in that regard, and now it is easier as technology allows us to get into the matter [of procurement].” (Purchasing manager, 2023).

Further, a view that this advanced technology is required is also noted; ”You almost need to have it if you are to do this in a large scale.” (Global sustainability advisor, 2023). The Procurement manager also shares some of the benefits that can be achieved with the use of a tracing solution, in which it is quoted:

”[Technology] can give us insight into numbers and facts, and [gives us the] opportunity to communicate it more efficiently. And getting that insight in a more structured way, that helps in making decisions based on facts.” (Procurement manager, 2023).

The lack of structured data can be a challenge for Grieg Seafood, exemplified by the Global sustainability advisor; ”One of the problems now is that we have too much data, and this creates noise. It makes it hard to extract essential information.” (Global sustainability advisor, 2023). Another challenge of being environmentally sustainable is mentioned by the Procurement manager as that this lack of structured data and insight is that a lot of actions needs to be done by guesswork and subjective evaluation. With tracing technology, it can make it easier to properly assess the initiatives and see the effects.

The use of technology in procurement can contribute to a competitive advantage, where it is stated that customers today are insatiable when it comes to requiring information and that if you as a supplier can provide this information you will be successful (Global sustainability advisor, 2023). Continuing, customer willingness to pay more for this information has been identified;

”I think the willingness to pay 1% extra, or 10%, for a product with an unbroken chain of

information, which have certifications according to the set criteria, (...) I think there will be a lot of faith in paying those extra [costs].” (Global sustainability advisor, 2023)

The use of a technology driven procurement strategy can have a multitude of effects for the value chain. In describing how a tracing solution could affect the procurement function, Global sustainability advisor explains that a tracing solution could provide the necessary security and assurance on the procured goods (Global sustainability advisor, 2023). Furthermore, the use of technology is stated to help create a supplier database, which in turn can provide insightful information and contribute to stimulate CE (Procurement manager, 2023).

However, the implementation of a system like this has been identified as needing to be done gradually (Procurement manager, 2023), which is also reflected by the Purchasing manager:

”In my busy day to day I am not happy that there are product certificates on low-level goods, that it is on small purchases. It is a hassle for me that sits alone and works with a large company.” (Purchasing manager, 2023).

Furthermore, it is expressed that these systems need human resources to be maintained and that it could possibly increase workload (Purchasing manager, 2023). Another point that was expressed was that for the systems to be successfully implemented, there needs to be trust in the data that are provided and that workers need to accept and respect these data (Purchasing manager, 2023).

5 Analysis and discussion

In this section, the results of the interviews will be analysed and discussed with the research framework as context. The research framework is illustrated in figure 12 and elaborated on in section 2.4 *Thesis framework*. This analysis is structured in accordance with the proposed framework, systematically highlighting the consequences of the results for each part of the canvas. This analysis will be performed to attain answers relating to the two research questions introduced in section 1.2 *Problem statement*:

RQ1: What is the potential of the procurement function in stimulating the circular value chain?

RQ2: How can new technology assist procurement in stimulating the circular economy?

The answers to these research questions will then act as the basis in which an answer to the problem statement of this thesis:

Problem statement: How can a technology driven procurement strategy stimulate the circular economy in the aquaculture industry?

In addition to analysing and discussing the findings from both the theory and the interviews, the methodology to achieve these findings will be reflected upon in this section. Furthermore, the findings in this thesis will be put into context of the findings of the specialisation project. By doing this, it will be possible to ascertain whether the results from this correlate with the current findings. Additionally, this can possibly highlight whether there are any differences and can make it possible to discover how things could have been done differently.

5.1 Procurement Enablers

The first part of the analysis aims to look at the enabling entities that act as a supporting baseline to enable procurement to perform its processes. As conveyed by Weele and Rozemeijer (2022), these enablers are in place to support procurement to achieve their financial and non-financial objectives. In this case, procurement objectives are defined to contribute to the organisational objective of stimulating a circular value chain. The analysis is structured to individually look at each of the enablers and the findings within, as described in the framework. In conclusion, to each enabler category, there will be a discussion summarising the results compliance to the framework.

5.1.1 Procurement Strategy

From the literature review, there were three interesting subjects that seemed to correlate with a procurement strategy that supports circular procurement activities. These three are sourcing circular materials, knowledge, commitment and top management support and sustainable business models.

At Grieg Seafood, there is some variation in the answers to how they assess their current degree of sourcing materials adhering to CE principles. The Global sustainability advisor (2023) states that it has gained a growing emphasis over the last few years and that CE principles sometimes surpass the cost principle in procurement. This can be interpreted as Grieg Seafood having an organisational strategy goal to stimulate

CE, but it may not be as apparent as a goal in their procurement strategy. Currently, the procurement strategy seems to conduct circular procurement on a project basis. However, it is also stated that the considerations required before such procurement decisions are extensive and sometimes hard to defend. The problem stems from the uncertain life-time costs of materials and products procured according to CE principles. The procurement of traditional goods usually guarantees a certain upfront cost and a somewhat certain lifetime. According to the Global sustainability advisor (2023), Grieg Seafood does not do such considerations to a comprehensive degree, but rather puts their trust in some of their suppliers to have good ideas about CE. This reflects a strategy built on trusting the supplier to manage their objectives, rather than being too involved in development processes.

There are policies at Grieg Seafood that focus on the recycling of products, especially in regards to the collection of ocean plastic waste. However, the Global sustainability advisor (2023) believes policies regarding circular procurement should be further specified. This supports the interpretation that Grieg Seafood has extensive strategic aims and policies in place at the organisational level. However, a procurement strategy regarding CE based on the organisational strategy is not clearly defined.

The Procurement manager (2023) in Grieg Seafood also states that CE principles are emphasised in their procurement today, but that they do not have any overview of the degree. Grieg Seafood is flexible in their procurement policy, based on how they purchase a broad range of products, goods, and services. Their current procurement strategy is built on exposing all purchases over 500.000 NOK to competition, although they are a private company and not compelled to comply with public procurement regulations. Grieg Seafood is committed to act transparent, and that also applies to their procurement processes. The procurement strategy at Grieg Seafood, in general, seems well defined, to the point of following the same principles as public procurement. As with most businesses, they want to focus on cost and profitability criteria in procurement, where best quality to best price usually wins. However, there is a balancing act weighting traditional procurement criteria, local presence, and now environmental sustainability, which has become a big part of their procurement.

Today, Grieg Seafood evaluates sustainability in every tendering process in procurement where it is relevant. This results in the challenge of creating any kind of universal criteria framework for the procurement of circular materials. Evaluation on whether to dedicate weighting to CE principles in a procurement process is conducted whenever they consider it relevant. However, the Procurement manager (2023) admits that this practise could be further concretised and that Grieg Seafood would surely benefit from a sharpened circular procurement criteria. There is not much clarity on how the procurement strategy supports circular procurement practises at Grieg Seafood aside from circular criteria being utilized when deemed relevant. To adapt eventual CE criteria for every process is resource intensive work, which could be released by adopting a procurement policy for circular purchases. The experience of purchasing products that promise to contribute to a more circular value chain has been accompanied by uncertainty. In the procurement of more sustainable fish pens, there have been concerns surrounding product quality, asking if the lifetime actually can be as good as for products of virgin materials. The Procurement manager (2023) has yet to see if this is the case, which often comes up as a problem with circular products. Circular procurement is often conducted on promises from suppliers without any actual proof of actual product performance, especially regarding product lifespan and recycling.

The Purchasing manager (2023) claims Grieg Seafood as forerunners in procuring recycled product and materials, built on their willingness to drive change in the industry. In sourcing circular materials, they want to challenge their suppliers to recycle and design products with circularity in mind. This is reflected in their vessel procurement, where they bluntly stated that they will not repurchase this vessel next time because they will demand a hybrid or battery-powered version next time. The Purchasing manager (2023) admits that evaluation on sustainability is supposed to be part of every procurement process, but that it happens at

least quite regularly. This is based on how they are very dependent on the quality and durability of some products, such as Dyneema fibre rope, where they cannot yet tell if it will be recyclable or not. However, they have not disposed of the ropes yet, and the Purchasing manager (2023) pressures relevant actors to explore recycling opportunities for such products.

Personally, the Purchasing manager (2023) believes Grieg Seafood is dedicated to the procurement of materials that support the principles of CE, based on the fact that most of the materials and products they possess are recyclable. In procurement cases where there are alternatives for circular procurement, although with higher costs, this regional office of Grieg Seafood is dedicated to taking the costs for a more environmentally friendly product. The Purchasing manager (2023) states that this is the responsibility of the organisation and will be so until there are better alternatives in place. The Grieg Seafood procurement strategy appears to be flexible enough to allow procurers to commit to circular procurement, but it hinges on the staff dedicating significant resources for each procurement process to include the principles of CE.

Flokk operates in a different industry, which requires a different strategy. The Chief design officer (2023) describes that the core of the organisational strategy at Flokk is to provide differentiated products. They compete in an international market and 80% of the output of their factory in Røros is exported. Flokk aims to industrialise on a larger scale than competitors. They develop close to all of the component blueprints by themselves, down to the smallest nuts and screws. Some standard fasteners, wheels, and gas lifts are purchased off the shelf. A typical Flokk office chair consists of about 150 unique components, most of which are designed in-house. When a product is to be produced, Flokk has a mature and competently crafted scheme for their product. All this without being dependent on some suppliers. Flokk do have some preferred suppliers for producing some components, but in general they put the production of components out for tender. Flokk commits to the make-to-order production model, which means that nothing is made to stock.

The Chief design officer (2023) states Flokk commits to two main principles for its products, health and welfare, and sustainability. Flokk were early adopters of pursuing sustainability, and early business analyses convinced them that material quality and product lifespan are key. In 1994 Flokk established their circular design criteria, which are especially apparent in their original brand HÅG, but also prioritised in all of their acquisitions. They have one primary supplier for all of their recycled plastics, where all of the injection moulding gets their supply. This single supplier strategy defines their product quality because they are aware of their capabilities. In sourcing suppliers for their components, Flokk is interested in documenting whether the materials are virgin or recycled. And if it is recycled, they want to know if it is post-industrial or post-consumer. Post-industrial waste differs from post-consumer because it is waste generated by manufacturing processes, and not actual used finished products. Flokk has been using recycled materials for their products for a relatively long time, which has also resulted in significant setbacks. The TOMRA-history was clearly a big lesson for Flokk, which has resulted in them being very specific about documentation in their sourcing of circular materials.

The history of Flokk sourcing fractions of waste because they stumbled across the opportunity in a research project substantiates how their procurement strategy is not only built on tendering. Flokk actively sources circular materials from other industries, in this case destroyed snow poles, which would have been incinerated, to use in a limited edition chair. They evaluate themselves as having control over their input of recycled material and its capabilities. However, Flokk are also interested in even better documentation for their circular material sourcing, especially concerning prior usage. The Chief design officer (2023) is convinced that a circular business model does nothing on its own, especially in their industry, except when the business model leads to a prolonged lifespan for the product. Flokk's business model is based on designing exceptional timeless products that are repairable. Their procurement strategy seems to support this business model in a circular sense by adding a good story behind their products. The limited-edition chair is produced

from waste fractions, which as a story promotes circularity. Making consumers affectionate towards their products can result in prolonged lifespans.

The statements of the Grieg Seafood interviewees make it possible to make a general assessment of their procurement strategy. Summarising the results of the interviews reveals that there are some elements in their strategy that support circular procurement. There is little doubt that as an organisation, Grieg Seafood is interested and committed to stimulating circular value chains and that this is to some extent reflected in its procurement strategy. The procurement strategy seems to be very flexible with a lot of room to consider circularity in every procurement process. When Grieg Seafood dedicates resources to source any material or product with circular weighting, they do seem to commit extensively towards this. They act as a challenger, or driver, towards their suppliers to innovate and deliver sustainable solutions. However, this flexibility can also be a hindrance for procurement managers in committing to circular procurement in an efficient way. This is especially highlighted in that they do not provide substantial policies in regard to how they should perform circular procurement, possibly making every procurement process more resource intensive.

It is difficult to determine how processes are conducted throughout Grieg Seafood's organisation due to the limited number of interviews. However, the Purchasing manager in one of the regional offices seems personally convinced of the CE concept, while also being dedicated to implement circular criteria in some of their sourcing. A procurement policy according to Procurement manager is to evaluate sustainability in all procurement processes, where it is relevant. This is in some way supported by the Purchasing manager that states that it should be evaluated in every process, at least in every new process. It is somewhat unclear how specific the policies are in regard to these evaluation processes, or if it is just a footnote that states to evaluate sustainability when it is relevant. However, this could be a weakness of the interview guide, where the question was to assess your procurement strategy in a general way. A deeper dive into the specifics of the policies may have been beneficial in revealing how deeply rooted the CE principles are in the procurement strategy at Grieg Seafood.

Flokk appears to have a well-defined procurement strategy, built on their organisational strategy and business model. They design almost all the components they use in production, with a mature and defined circular design principle. Flokk designed their circular design principles in 1994, and has since actively sourced recycled plastics for their production. The procurement strategy seems to be well suited for circular procurement, where the limitations of circular procurement are based on the market supply of circular materials.

5.1.2 Procurement Organization

Weele and Rozemeijer (2022) defines the procurement organisation as the way an organisation formally sets up the procurement process, its coordination across business units, centralisation degree of activities, and definition of primary tasks and responsibilities. In the framework there are two entities which reflect a procurement organisation with circular objectives: collaboration and knowledge, commitment and top management support. The procurement organisation is typically defined in a way that should reflect the procurement strategy, both with the goal of achieving the procurement objectives. From the interview results, there are assessments to be made regarding the procurement organisation at Grieg Seafood and Flokk.

Grieg Seafood is committed to act transparently and their code of conduct and purchasing policy are defined to reflect this. All purchases over 500.000 NOK are exposed to competition. The Procurement manager has the responsibility of keeping the code of conduct for procurement up-to-date and ensuring that all of their regional offices follow this code of conduct in their processes. This indicates that there is coordination

across their business units to formalise their procurement processes, while also providing the regional offices certain flexibility to act within defined procurement policies.

In general, Grieg Seafood follows the typical cost and profitability principles in their procurement but has in recent years put significant weighting on sustainability aspects in their purchases, especially regarding local presence and environmental sustainability. Most procurement processes are conducted regionally, by regional managers such as the Purchasing manager. However, the Procurement manager receive requests from regional offices to help with smaller purchases. The Procurement manager (2023) assess their procurement organisation as semi-centralised. In general, the responsibility of supplying Grieg Seafood's daily operations is left to the regional procurement departments. Top management are, however, an available resource for knowledge and support in conducting any procurement process.

The Procurement manager (2023) explains that most of the procurement processes are carried out using IT solutions, which are provided by their suppliers. There are systems in place for reorders, which helps streamline daily procurement tasks. This is also important for Grieg Seafood to ease transitional periods if employees were to quit or procurement responsibility were to change under any circumstance. Grieg Seafood also operates in a strictly regulated industry, requiring its equipment to be of a certain quality to ensure secure and legal operation. This is reflected in how procurement dedicates significant resources in defining strict specifications in sourcing processes, as well as constantly posing challenges to their suppliers in innovation of new solutions.

This may be a weakness of the interview guide in not digging deeper into the specifics of the code of conduct and the formalised procurement process. The assessment of how the primary task is defined, as well as the set-up of procurement, is based on the perception of the interviewees, and not necessarily a reflection of how it is meant to be performed. There may have been interesting findings on how strictly the actual practical work at procurement is carried out in comparison to their policies and code of conduct. The assessment, however, does indicate that the Purchasing manager is dedicated to adhere to the policies as they are described by Procurement manager. As discussed concerning Grieg Seafood's procurement strategy, it is not clear how their circular procurement processes are defined. It seems to be performed at times when it is deemed relevant, but it is hard to extract any information concerning when and how a process is deemed relevant.

It is a harder challenge to specifically assess the procurement organisation at Flokk. A lack of interviewees from the company, and the one interviewee not working on procurement tasks daily, may be a weakness of the upcoming assessment. The Chief design officer (2023) explains that they are independent of their suppliers because of how they design most of their components in-house. In sourcing processes, Flokk will advertise a detailed description of the component they have designed, and then suppliers will have the opportunity to compete in a tendering. While there are criteria at Flokk for suppliers to be capable of producing the component following their design, they also have requirements concerning delivery precision and lead times.

Naturally, Flokk has to procure quite regularly because they follow a make-to-order production model. This is, however, a highly automated process for procurement. When a product is ordered on Flokk's online configuration tool, customers will receive a configuration code which can be used to confirm their order. When an order is confirmed, the configured product order information is sent to Flokk's production, as well as a call-of-order to almost every single supplier with details of which components are needed. There are some suppliers with sporadic deliveries which may require more traditional manual procurement.

In sourcing at Flokk there are procurement managers for different categories, such as plastic. This seems to be a traditional sourcing process with regular meetings, negotiations, and adjustments of designs according to supplier capabilities. There is not a lot of empirical data on which to base an assessment of Flokk's

procurement organisation that acts as a direct enabler for circular procurement. However, Flokk seem to have a very clear idea and vision of how they can contribute to sustainability in an efficient manner with their procurement.

As discussed in the context of their procurement strategy, Flokk is actively looking for an increased supply of recycled materials in their products. They have established supplier relationships with suppliers, which defines the quality of the chairs Flokk produces, based on the properties of the recycled plastics. On this basis, the procurement organisation does seem to have defined processes and coordination across their business units which ultimately result in a supply of sustainable components for their production. It could be likely that at least one more interview with a procurement responsible at Flokk could result in better empirical data on which to base this assessment.

5.1.3 Procurement Staff

Weele and Rozemeijer (2022) defines the procurement staff of their canvas as the knowledge, skills, and competences that are required in the procurement function. In addition to the general competence required to perform efficient procurement processes, sufficient knowledge and a good understanding of the complexity of CE is important to drive CE (Neessen et al., 2021). In the thesis framework, there are two central entities dedicated to procurement staff: collaboration and knowledge, commitment and top management support.

At Grieg Seafood it is reasonable to assess how its procurement staff acts as an enabler for circular procurement by analysing the empiric data provided by the Procurement manager and the Purchasing manager. These two subjects are procurement workers at different levels and in many ways will define what the procurement staff at Grieg Seafood is. The Procurement manager (2023) defines CE as the circulation of products that have received a prolonged life or have been re-utilised in some way. This definition is similar to those found in the literature, especially the one provided by Geissdoerfer et al. (2020), which emphasises slowing, closing, and narrowing material loops by repair, reuse, remanufacturing, refurbishing and recycling. The definition provided by Procurement manager (2023) is similar to one of the main principles of CE as well, to circularise product and materials. The Purchasing manager (2023), as an procurement professional, believes that CE is about raw materials and products having a life after its original use. While not as directly comparable to other CE definitions, it is similar to what some literature describes as maximizing utility and value in products at all times, such as described by Webster (2015).

In general, the procurement staff interviewed at Grieg Seafood seems to have knowledge about CE which largely matches popular definitions. This does not necessarily reflect how they grasp the complexity of the concepts. As explored in the literature review, a frequently critiqued aspect of CE is how cluttered the definition of the concept is, and therefore it is inappropriate to state any specific definition to be the one that any procurer should follow. However, it can be argued that Grieg Seafood as an organisation could define CE as a concept internally for all business functions, such as procurement, to learn and follow.

However, there are more empirical data to assess the knowledge of procurement staff on CE. The Procurement manager (2023) states the importance of the Global sustainability advisor (2023) as a collaborative ambassador at Grieg Seafood in challenging business functions to be sustainability-minded. This provides learning opportunities for procurement to gain more knowledge about development in the field of CE. Collaboration is commonly identified as one of the most important aspects of CE, as it concerns actors in the entire value chain. It seems that both interviewed procurement workers understand its importance. Both frequently raise how Grieg Seafood acts as a challenger and driver for its supplier base to innovate and deliver sustainable solutions.

They also seem to realize some barriers of procuring circular materials and products. Currently, many of the more circular alternatives at the market is significantly more expensive than its virgin counterparts. Often enough it is too expensive to be able to defend procuring these circular products. However, there are times procurement considers the trade-off between cost and sustainability in favor of sustainability. This reflects how they may have realised that stimulating CE may also be a competitive advantage in the long term. Although the upfront costs of circular materials may be more expensive, the long-term savings in cost from prolonged utilisation and value may cover the expenses. The Procurement manager (2023) and the Purchasing manager (2023) also point to how their customers increasingly prioritize sustainable products. This may indicate that their grasp of how sourcing circular materials and products may be necessary to retain and grow their customer base, which is ultimately what drives profit for the organisation.

The way in which procurement staff identify the potential benefits of advanced technologies is also interesting. The Procurement manager (2023) points to how important it is to make decisions in procurement based on facts. Currently, Grieg Seafood is under a challenge to make informed decisions about circular procurement because they lack sufficient insight. There are subjective evaluations based on speculation and guessing, highlighted in their procurement of fish pens. The Procurement manager (2023) sees how ICT solutions and tracing technology can provide efficient sharing of information between supplier and procurer, as well as a way to attain structured insight. This insight could enable Grieg Seafood to make better decisions faster. However, the Procurement manager (2023) also sees the challenge of such systems. They are usually complex and require significant investments to implement. The Procurement manager (2023) understands that implementation efforts need to be gradual and in collaboration with suppliers.

The Purchasing manager (2023) did not provide concrete answers on their view of the potential of advanced technologies in assisting procurement for CE. The results from the question indicates some worries about how advanced technologies may require increased work efforts from procurement. It may also indicate that the Purchasing manager (2023) does not have extensive knowledge of what advanced technologies entail. This could, however, be another weakness in the interview guide. The interview guide may require the interviewees to have some prior knowledge of the technological solution in procurement to result in solid empirical data. It could have been appropriate to provide more specific examples to the interviewees and some explanation of what advanced technologies entail. This is substantiated by the fact that Grieg Seafood is not a forerunner in using technology in its procurement, where technological interaction is limited to Excel and email.

Grieg Seafood does not appear to employ a large procurement team. The Purchasing manager (2023) states that there is already a heavy workload with current responsibilities, especially with regard to certificates on low-level goods. This can be a limiting factor in the collective resources that procurement staff have. The Purchasing manager (2023) indicates an increase in workload with the introduction of technological solutions, since they require human resources to maintain. This may be an argument for the fact that the competence of procurement staff is also limited by the sheer amount of available workforce. While this is a consideration for the deployment of advanced technologies, it may also be applicable for circular procurement practise. Reinforcing the procurement function with knowledgeable workers may increase the competence of the function and facilitate internal collaborative processes.

There is no fair empirical data basis to assess the procurement staff at Flokk. There was only one Flokk interviewee, again not a procurement worker. The decision to not interview any additional Flokk interviewees was based on the holistic insight the Chief design officer (2023) possessed. However, in retrospect, an interview with staff working with procurement on a daily basis could provide some data basis to assess this enabler at Flokk for CE. Although the results of the Flokk interview provided extensive information about their procurement processes, procurement staff is deemed to be about worker competence and knowledge, and it would only be fair to assess this on data from a direct source.

5.1.4 Procurement Systems

In the enabler of procurement systems, there are two findings which are placed within the thesis framework: Technology for supply chain transparency and information and communication technology. As found in the literature, these technologies can provide data on products and suppliers, so that a more informed decision-making process can be achieved. This demand for more data is also seen from the empirical findings, in which there is always a desire for more data. This demand for data comes from both internal departments and external suppliers or customers.

In the current situation, there are no organised ICT solutions at Grieg Seafood. With an ICT solution, an organisation could possibly see an increased data flow, so that decision making on the basis of CE principles could more easily be performed. Furthermore, an ICT solution could provide the necessary systems to organise suppliers more systematically, possibly based on CE considerations. An ICT system could also provide the necessary workload alleviation to properly perform circular procurement. This is seen from the findings, in which it is described that there is not necessarily sufficient resources in organisations with small procurement departments to provide the required information. With an ICT solution, this work could become less resource intensive as the data is already structured and organised. With increased collaboration with suppliers and stakeholders, there is also the possibility to create parameters which are of interest to these actors, and thus make it even more accessible and less resource intensive.

ICT solutions, in addition to other advanced tools, could make it easier to monitor the quality of the products used. With this, it might be possible to assess whether the equipment is in need of repairs or modification. However, as the safety regulations in the aquaculture industry are stringent, this might be redundant. With the stated newer standards, there already seems to be systems in place in which parts of the equipment are certified. Nevertheless, the use of technological advancements in assisting the re-certification of equipment to increase lifetime is an interesting topic to explore.

Thus, ICT can be an enabler in achieving CE objectives, as it can provide structured insightful information for the organisation. Furthermore, as seen from the literature, ICT can be considered an antecedent to the further implementation of advanced technological implementations, such as technology for supply chain transparency (Zhang et al., 2016).

Technology for supply chain transparency is the second finding to be placed within the procurement system enabler. As seen in the empirical results, there is experienced a reluctance from suppliers in providing data, in fear that it would be shared further and that the data are the supplier's own property. Implementing a solution in which the data is shared, through structured means, can possibly increase the collaboration between buyer and supplier. Moreover, this solution could possibly increase the levels of trust between these two parts. With this increased collaboration and trust, clarity can be achieved in procurement decisions. With this clarity, it can thus be easier to procure materials and products that are in line with the principles of CE. As an enabler, technology for supply chain traceability can also ensure that products purchased made from post-consumer plastic are in accordance with the regulations, e.g., the standard NS-9415. With this virtue, it might be easier to procure products that have at least an equal lifetime of products made from virgin materials.

Technology for supply chain transparency is thus an enabler which can provide information relating to the procured products and materials. Alongside ICT systems, this can provide decision support on the sustainable qualities of these procured goods. However, advanced technology for supply chain transparency might require substantial investment and prerequisites. Without an investment into baseline system, this technology can work alongside, and moreover, with a sufficient digital maturity in the organisation, it could be more complicated to implement technology for supply chain transparency.

5.1.5 Procurement Performance Management

Procurement performance management is the last enabler to be included in the thesis framework. Within this category two findings are included: objectives reflecting circular economy practises and information and communication technology.

Within objectives reflecting CE principles, there are three elements: Eliminate waste and pollution, circulate products and materials, and regenerate nature. With procurement performance management, it is possible to measure the impact the organisation has on these elements. By developing sustainable metrics on procured products, it might be possible to create an overview of the impact that the procurement function has on CE. With this information, investments made to decrease environmental impact might be easier to defend, both towards internal top management, as well as external stakeholders and possible shareholders.

With a performance management system, it could assist in creating metrics on lifetime costs on products. This can provide a decision support basis for procurers to evaluate suppliers on the environmental impact the products and materials have throughout the lifetime of the products. This is opposed to just evaluating based on cost and environmental impact on production. This is also supported from the empirical results, in that these are considerations which needs to be made in today's operations. Moreover, it is stated that without sufficient performance management in regard to CE, it is somewhat of a barrier in circular procurement.

With an overt overview of the impact the procurement function has in reducing climate footprint, further investments into the procurement product groups that need to be optimised could be more easily identified. This could act as a stimulus for these suppliers and could contribute to the circularity of the value chain.

To properly assess performance, metrics must be analysed. ICT solutions can provide sufficient product information to create balanced metrics in which to monitor CE impact. As seen in the empirical findings, these metrics could include resource input, output, or resource utilisation. An interesting example of procurement performance management was posited in the empirical results, in which suppliers had to provide information on the climate footprint in kg per tonne of CO₂. With the use of performance measurements such as these, it could provide a decision support basis for the procurement function. This can make it easier to procure the most environmentally sustainable solution while still considering elements of cost-effectiveness. With the use of ICT the data on these metrics could be structured systematically. This can then give more oversight on which supplier is performing the best, and thus making it easier to select these.

ICT could then act as an enabler for procurement performance management. This is done by collecting and organising the data. By these virtues, it is possible to create metrics to assess the CE impact the procurement function has on CE issues. With better data on this, further investment and support in circular procurement could possibly be attained.

Although there are posited examples on how the sustainable performance could be evaluated and how ICT could influence this, the further development of a comprehensive performance management system will not be performed in this thesis, but it is nonetheless an interesting topic in CE studies. This can occur at both the supplier level and within the procurement function itself.

5.2 Procurement Processes

As stated in Weele and Rozemeijer (2022) there are three procurement processes that are of interest to analyse. During the interviews, it was found that many of the elements described in the literature are relevant for the case study. In this section, the various findings from the interviews corresponding to each topic within these enablers will be analysed and put in context of the framework and the theory described within.

5.2.1 Supplier (relationship) management

In the thesis framework, there are three findings related to supplier management; Information and communication technology, collaboration, as well as knowledge, commitment and top level support. As stated previously, information and communication technology (ICT) is included in the supplier relationship management process. This is because the nature of ICT can provide an information flow so that joint development and collaborative processes with suppliers can be handled. This need for information is a recurring theme from the interviews, both towards Grieg Seafood's suppliers, but also towards their customers. By implementing ICT solutions, Grieg Seafood can possibly fill this demand for data, whether it be on provenance of materials, quality or amount in the supply chain. This ICT solution should then act as a baseline in which the other advanced technologies, such as tracing solutions, could work alongside. As stated above, the need for an ICT solution, such as an ERP system, is apparent from the interview results, especially as the requests for information from both suppliers and customers impose a toll on the workload of the strategic workers. Although this workforce alleviation could arguably be placed within another category in the canvas, it is deemed to fit in supplier relationship management, as the effects of an ICT implementation could free up time. With this reduced work load, procurement function workers could spend more time nurturing supplier relationships and possibly increase circular supply chain performance.

In supplier relationship management, there also seems to be a perception of the workers on some of the benefits ICT, in that of supplier categorisation as well as building a database of suppliers. This perception aligns with some of the theoretical findings and could be one of the ways in which supplier relationship management could be affected. This benefit also aligns with the statements of the interviews, in which a lack of insight and oversight of the suppliers is seen as a challenge in current operations. Furthermore, it is stated that this increase in insight, by structured information, could assist in decision making. This could then make it easier to perform circular procurement.

Another benefit of technological innovations in the procurement function is increased supplier collaboration. With increased collaboration, it could become easier to develop new technologies and products that adhere to the principles of the circular economy. Furthermore, as shown by examples from the findings, increased supplier collaboration could further enhance the modification of existing equipment to comply with certification regulations. Increased collaboration with waste handlers could possibly make it easier to stimulate the demand for recycled plastic by ensuring the provenance of the materials supplied, as well as the act of having a collaborative relationship itself can assist in stimulating the supply of recycled post-consumer plastic. Some of these benefits could also be achieved with technology for supply chain transparency, but is nonetheless included in this entry of ICT. With ICT and technology for supply chain transparency being somewhat interlinked it is deemed that it would not pose as a detriment to the framework.

Technological innovations can thus increase collaboration, but as previously stated, technological innovations also require collaboration to achieve the goal of the circular value chain. Especially the points of goal alignment, partnership trust, and stakeholder acceptance are found to be of high relevance when it comes to supplier collaboration. By aligning goals with the suppliers, a sense of common direction might be created,

including the feeling that they "are on the same team". This sentiment is also reflected in the results of the interviews, whereby if Grieg Seafood were to establish a sustainable procurement strategy, they could achieve preferential status with both their customers and their suppliers.

Partnership trust was also found to be a challenging factor in the results. It seems that some suppliers are reluctant to share information with Grieg Seafood can indicate that there exists uncertainty on the supplier side on what the intention is on the use of the data. This challenge can be mitigated by goal alignment, by sharing the circular vision that the organisation has, but also with transparency. By the increased transparency offered by technological tools, the supplier could possibly be assured that the data are used for its intended purpose and that there are no ulterior motives. Increased transparency can also make it easier for organisations to know which suppliers adhere to their code of conduct for suppliers, as well as their CE principles.

For the collaboration to work in stimulating the circular economy, it requires that there exists stakeholder acceptance. This is necessary for the technology, and thus the collaboration, to have the intended effects. Thus, this stakeholder acceptance can be seen as relating to goal alignment, in the sense that for the collaboration to achieve effects in stimulating for CE, the solutions and technology needs to be used to its fullest potential. To do this, stakeholders must accept and respect the solutions. And followingly, for the stakeholders to accept the solutions, the philosophy of CE and the goals to achieve this needs to be aligned. These points can also be seen from the interview results, in this case when discussing internal stakeholders. These same sentiments were shared that for the technological innovations to have effect, they need to be both respected and accepted.

In the process of supplier relationship management, knowledge, commitment and top level support are all important factors. Both for procurement's potential in stimulating the circular value chain, as well as for technology in enhancing these procurement efforts. On the topic of knowledge, it was found from the interviews that there was a lot of knowledge required in regards to how products should be recycled and which processes to achieve this would be of most relevance. While this can be seen as relating to strategic sourcing (of recycling services), it can also fit in the supplier relationship management. This because both the suppliers and the organisations need to have sufficient knowledge about both the industries, as well as the specific processes to be performed. This is required to achieve the maximum yield of the products delivered to recycling.

As stated previously, goal alignment and stakeholder acceptance are vital points. It can thus be seen that, for this to be properly achieved, there needs to be commitment in achieving the CE goals. It is seen from the literature that this commitment most often comes from top level support. In this it is implied that the goals of CE, and, further, environmental sustainability, are anchored in the organisational strategy. If this top level support is lacking it might be harder to achieve sufficient commitment from the procurement function, besides the rest of the departments, and thus make it harder to both attain and manage suppliers which adheres to the principles of CE. The implementation and use of technological tools in enhancing the procurement function's potential in stimulating for CE can also be seen as requiring top level support. This is because of the cost aspect of the implementation. It can be assumed that the acquisition of extensive ICT solutions and advanced tracing solutions would entail substantial costs for the organisation. For this to have success in enhancing supplier relationship management, it would then be required that the management is on board with both the concept of CE and the technology, and that CE is the true objective for the implementation. In both Grieg Seafood and Flokk's case it does seem that there exists sufficient top level support and commitment throughout the organisations. This thus makes the process of supplier relationship management easier, in that it is clear for the supplier what the goal of the CE initiatives are, and then again facilitates goal alignment.

When it comes to technological innovations to stimulate the CE efforts of procurement functions, commit-

ment and top-level support can be especially important. This comes from the aforementioned principles of acceptance and respect of the solutions, both from the internal workers that use the solutions and from the suppliers. Suppliers without their own knowledge, top level support and commitment to CE principles might not understand the decision making of an organisation which adheres to these principles. This can be substantiated by interviews findings, in which CE processes that were implemented met reluctance from some of the suppliers. The role of an organisation which is further along in the CE journey could then be to share this CE knowledge with their suppliers, either directly through workshops or seminars, or indirectly through supplier selection and sustainable criteria. This is also supported by the findings from Brown et al. (2021) in which buyers and suppliers influence each other in the value chain. Thus, the procurement function can stimulate their suppliers to act more according to CE principles, and in turn, the function then stimulates the circular value chain.

With choosing Rozemeijer's Weele and Rozemeijer (2022) procurement canvas as a basis for the thesis framework, there are some elements from Monczka's van Weele (2018) model which are not overtly described. Specifically where Monczka 2018 models in-sourcing and outsourcing, as well as the development of commodity strategies. These give a good view on decisions and processes in general procurement. However, for this thesis, in exploring how procurement can stimulate the circular economy, these topics are not necessarily of the same degree of relevance.

5.2.2 Strategic Sourcing

Strategic sourcing is the second of the procurement processes that are included in the thesis framework. Within this, two findings from the literature are included: sourcing circular materials and sustainable business models. On the sourcing of circular materials, it is defined as a process, as this is one of the main tenets of the circular economy. By sourcing products and materials from suppliers that adhere to the principles of the circular economy, the buyer would then itself adhere to these principles. By sourcing circular products and materials, the buyer could then achieve the points of less output, higher value retention, and lower required input. As stated above, the sourcing of circular products and materials is the main effect that the procurement function has in stimulating circular value chains. By creating sustainable criteria that suppliers must adhere to, this is one of the main instruments in which this effect can be achieved. This is also reflected in the findings from the interviews, in which it is stated that most tenders are subject to sustainable criteria.

One theme that was seen in the interviews was that of whether these sustainability criteria should be implemented on every purchase, or rather the ones where it is deemed relevant. From the results in the interviews, it is seen that Grieg Seafood today evaluates the environmental sustainability in every tender, but only where it is relevant. It is explained that this comes from the influence, or lack thereof, that Grieg Seafood has on suppliers. It is stated that it is easier to subject suppliers in which Grieg Seafood is a large customer to the required sustainable criteria. However, in smaller purchases, it can be construed that Grieg Seafood does not necessarily have the required market influence to set sustainable criteria for these suppliers. While this point has credence, the power of the purchasing function in regard to stimulating the circular economy lies in setting sustainable criteria to set the standard of expected CE characteristics of the products. By refraining from subjecting suppliers of these small product groups to sustainable criteria, it can result in these suppliers not knowing the stance the buying organisation has on CE. A result of this could be that the transformation into a circular economy is stymied in these industries. This point of using sustainable criteria to stimulate suppliers for CE is also reflected in the findings of the interviews, in which a continuous effort to establish sustainable criteria can increase the overall supply of circular products. It is then seen that this would increase the overall competitiveness of circular products. In the end, these efforts of the procurement function could help their suppliers improve CE, so the bottom line also sees these environmental sustainability

effects.

However, a balancing act between cost, quality and environmental sustainability is described. It is found in the results of the interviews that while Grieg Seafood wants to be sustainable, it also needs to maintain a cost focus. This economic sustainability can be seen as common sense in the operation of the company. Economic sustainability could then argue against the aforementioned imposition of sustainability criteria on small volume products. This can either result from the cost of the sustainable variants of these products being more costly than the environmentally sustainable versions. More likely, as seen in the results, the quality of recycled variants of these products is often lower than that produced from virgin materials. These quality criteria can be seen as weighing more than the cost aspect, especially at Grieg Seafood. There seems to be a consensus among the interview subjects at Grieg Seafood that environmental considerations often supersede cost considerations, but they would never compromise quality. This comes from strict regulation regarding the operation of fish farms, with both animal welfare and escape risk.

Another effect of strategic sourcing of sustainable materials is that of discovering the relevant suppliers from which these materials can be sourced. This process can be seen from the interviews, especially from the examples at Flokk, where it seems that the discovery of these suppliers happens rather sporadically. The use of ICT solutions can help create tools, such as a supplier database, so that the mapping of relevant suppliers can be performed. Therefore, this can make it easier to find suppliers of recycled materials that have the required qualities. Another effect technology can have on strategic sourcing is by reducing the reliance on a single provider of materials. As seen in the findings of the interviews, it is apparent that Flokk sticks to a single provider of recycled materials, as the quality and capabilities of that supplier are ensured to be what Flokk requires for their products. With the use of a blockchain tracing solution, it would have the benefit that the provenance and qualities of the products are irrefutably known. By using these virtues, it could have the effect of reducing reliance on a single provider and thus make it easier to operate a multi-sourcing strategy, also on recycled products and materials. This can then help the organisation achieve the benefits such a strategy would entail. However, this requires that the technology be prevalent in the recycling industry. Whether this contributes to a lock out of suppliers not participating in the technology is not known and could be an interesting future topic to consider. This can, however, be seen as a way in stimulating the value chain to become more sustainable and is thus of relevance. It can be argued that this specific point could also fit within supplier relationship management but is of redundancy matters only stated here.

Sustainable business models is the second finding included in this strategic sourcing process. The elements which are included in this point is that of the change from a traditional ownership model to that of a collaborative or circular business model. Included in this is the product service system as proposed by Witjes and Lozano (2016). As stated previously, this PSS can enhance CE efforts in that ownership of the product is retained with the producer, and the buyer simply pays for the service that the product offers. With this, the maintenance of the product is the responsibility of the producer. This would then incentivise the design of more durable products and thus is in adherence to the CE principles. Procurement can influence supplier business models by setting criteria for how business models such as PSS should be implemented. An interesting topic seen from the interviews is that for the sustainable business model to have effect, the products themselves have to be produced sustainably, and moreover maintained. Without this, the enactment of such a business model would have no effect on contributing to the circular economy. This can also be seen with Jevon's paradox Schröder et al. (2019), in which increased consumption of materials might offset the sustainable efficiency improvements. The act of maintaining the products, so that the lifetime reaches its fullest potential is a crucial element in this, and constitutes what Bocken et al. (2016) calls "slowing the loop". Further in sustainable business models in regard to strategic sourcing could be the act of sourcing products which can easily be modified and re-certified to reduce the input of new equipment. In addition to this, the procurement function has to facilitate and collaborate with suppliers, so that the procured equipment can be maintained to the maximum extent of its useful life. It can be seen from the results that this action is

already being carried out.

In this process of strategic sourcing, it could thus be seen that the potential of the procurement function in stimulating circular value chains is indeed the sourcing of circular materials. This is done by setting criteria to which the suppliers are to strive to achieve. Moreover, with the procurement function setting criteria for sustainable business models at their suppliers, the stimulus for CE transformation can be further achieved. The use of technology in strategic sourcing could help the procurement function alleviate dependence on single sourcing strategies, as the provenance and qualities of the purchased products and materials are ensured.

5.2.3 Supply

On the topic of supply as a procurement process, two findings were found to be appropriate to place within this process: Technology for supply chain transparency and information and communication technology. As seen in the literature, supply relates to the optimisation of the ordering process, as well as the management of the incoming materials flow.

With technology for supply chain transparency, it would be easier to know for certain the qualities of ordered products. With this benefit, the decision making in circular procurement could become easier, as the information provided presents an opportunity to make decisions which adheres to the CE stipulations in the organisations procurement strategy. This element is reflected in the findings, in which it is described that with structured and insightful data on products and suppliers, it would be easier to make good decisions. This could then also be construed in that with structured and insightful information relating to the CE properties, e.g. greenhouse gas impact per product, the same facilitation of good decision making can possibly be achieved.

The creation of KPI's on the sustainable properties of the products was found to be a topic of interest as well from the findings. With the use of technology for supply chain transparency, this could also be achieved with the same benefits as described. Furthermore, by having transparent information relating to the qualities of the products and the aforementioned KPI's, it could facilitate the creation of more concrete sustainable criteria. This could in Grieg Seafood's case help create universal criteria for all their suppliers. With these enhanced sustainability criteria, it could then facilitate the stimulation of CE principles at the supplier level, as it is found from both the literature and the findings that good sustainable criteria have an impact on both greenhouse gas emissions and local value creation. However, the implementation of technology to increase traceability could be considered an advanced technology to facilitate the circular economy. It could also be argued that there are less cost-intensive initiatives to provide these benefits. Therefore, the low hanging fruit of CE benefits may not necessarily be achieved with advanced technology for supply chain transparency. It is nevertheless seen as a valuable initiative in the transformation into a complete circular economy, the closing of the loop.

The use of ICT could also be seen to be related to the optimisation of the supply process. ICT could assist the organisation in reducing the time spent on operations, as it is found from interviews that a lot of time is spent on supplier follow-up and the retrieving of information regarding the products. With the implementation of various ICT initiatives, the procurement function could possibly see a more optimised ordering process, based on both cost and sustainable criteria. This can in and of itself help to achieve a more circular and sustainable value chain, but ICT could also free up time so that other CE initiatives could be carried out by workers. This can be seen in the findings, in which the time spent operating and maintaining the reporting systems was seen as a barrier, as the work load could exceed the capacity of the workers.

The technology for supply chain transparency and ICT could then help the organisation in stimulating the circular value chain by providing information on the products and materials in the value chain, as well as optimising the procurement processes. With these benefits, the decision basis for making choices adhering to CE principles can possibly be increased, thus increasing the potential of procurement functions in stimulating the circular value chains.

5.3 Procurement Objectives

In the thesis framework there are two objectives that are aimed at being fulfilled with the mentioned enablers and processes. These two objectives are financial and non-financial objectives. In addition to these two, there is another organisational objective, which is the transition into a circular economy, illustrated by the ProBiz4CE framework (Witjes & Lozano, 2016).

In terms of financial objectives, the circulation of products and materials in the value chain is the finding that is found to fit the most accurately within this category. The widespread circulation of products and materials can facilitate the creation of a new market in which the buying organisation can transition its role from a consumer of products and materials to a producer of post-consumer plastic. This could then be a market opportunity in the sale of these materials. Moreover, in the financial objectives of CE, the maximum retention of value of the equipment used in production, and thus the reduction of the need for new products, can adhere not only to the principles of CE but also to that of economic sustainability. However, this can be seen as requiring a widespread adoption of the CE philosophy throughout the value chain, and it is thus required that the CE be stimulated in the value chain to a degree that it is cost-effective to carry out these initiatives. Moreover, with the increased circularity of the value chain, and the increased maturity of this principle, some of the concerns regarding quality, lifetime and ability to recycle of products can be alleviated. As seen in the empirical findings, this is not necessarily the case in today's operations, and thus substantiates the need for this stimulation.

In addition, organisations within the aquaculture industry can see that economical sustainability is preserved in that there can be a market opportunity to provide products with a well-established trail of information on the sustainable qualities of their products. The organisation could then cater to a market in which these issues have a prevailing weighting. A market which can be considered to be increasing as the effects of human environmental impact continue to increase. This opportunity was also reflected on in the empirical findings, in which it is seen to be of a market value, especially in developed countries, to pay more for products which have this in place. Continuing on the market opportunity, the point of corporate social responsibility, and that the value of CE efforts also lies in the reputation of the company were also found in the interviews. While this could also be argued to be lying within non-financial objectives, should the organisation seize the opportunity to cater to this aforementioned sustainable-minded market group, they could possibly see the financial objectives being fulfilled as well.

While financial objectives are important for the initiatives to be worthwhile and possible to perform, the non-financial objectives can be seen to have precedence when it comes to the circular economy. The findings included in this point in the framework include the elimination of waste and pollution, the circulation of products and materials, and the regeneration of nature. These three points all constitute the main principles of CE. By stimulating more circular value chains, the procurement function can thus be seen to influence the organisation to complete these points. By eliminating waste and pollution, the organisation could reduce the impact the aquaculture industry has on the environment, both globally through the reduction of greenhouse gas emissions, but also locally through the reduction of the harmful activities its production has on the local environment. These circular efforts can also be seen as including the point of regeneration of nature.

The act of stimulating the competition can also be considered a non-financial goal. By demonstrating the effectiveness of a CE strategy, other actors in the aquaculture industry, and possibly other industries as well, could try to replicate these effects within their own organisations. This is also seen in the literature, especially Brown et al. (2021), in which organisations are seen to influence each other when it comes to circular practises. This, in turn, could make the industry as a whole more sustainable.

With these financial and non-financial objectives being fulfilled, it can be considered that the transition into the circular economy as depicted by Witjes and Lozano (2016) is also fulfilled. This, however, can be considered as being more comprehensive, as it also includes the alignment of business models between buyer and supplier. However, this is still relevant as these are initiatives that could be taken to further achieve these described objectives. With the help of advanced technology, such as tracing solutions and other ICT solutions, this collaboration could be facilitated, so that the effects of CE, both financial and non-financial could more easily be achieved.

The transition into CE can thus be considered to reach these financial and non-financial objectives. These changes could be stimulated by the procurement function through the various mechanisms described in this section. With these objectives fulfilled and achieved, the transition into a circular economy can be considered as achieved. These mechanisms could then be considered as constituting the potential technology-driven procurement has in stimulating the circular economy.

6 Conclusion

The purpose of this thesis was to explore how a technology-driven procurement strategy could stimulate the circular economy in the aquaculture industry. With the help of a qualitative case study on two actors with participatory interest in the post-consumer plastic value chain, as well as a narrative literature review, the problem statement and the following research questions were answered. In this section, the answers to each of these research questions will be stated, as well as the concluding answer to the problem statement. These answers will be presented sequentially to each research question. In addition, reflections on the work done in the thesis will be presented, as well as suggestions for future research.

6.1 Research questions and problem statement

RQ1: "What is the procurement function's potential in stimulating the circular value chain?"

In this thesis many facets of the potential on how the procurement function could stimulate the circular economy have been explored. First of all, the setting of sustainable criteria for supplier selection, and specifications for circular products is a crucial element in this potential. The creation of a universal circular procurement strategy could be included in this, where these criteria should also be applied to low-volume suppliers. This could then stimulate these suppliers to enact circular strategies themselves, while also influencing other actors within the aquaculture industry to do the same. The procurement function can contribute with aligning the organisation's CE goals with those of their suppliers. This however requires top level support, and that the CE goals are anchored in the organisational strategy. It is found that purchasing circular products are accompanied by uncertainty. These concerns relate to product quality, lifetime, as well as uncertainty on whether long lasting products and equipment can be recycled as advertised. An increased adoption, and maturity, of the use of circular products could in the future alleviate some of these concerns.

With these acts, the demand for circular products and materials could possibly increase, and thus decreasing the environmental impact that stems from the production, while increasing the cost-effectiveness of post-consumer plastic. In addition, sustainable business models which increases product lifetime should also be implemented, such that the increased production footprint for recycled products does not exceed the environmental impact it mitigates. A part of the potential of the procurement function in stimulating the circular value chains lie in stimulating the suppliers to implement sustainable business models. These main activities then indicate the potential the procurement function has in stimulating the circular value chain.

RQ2: "How can new technology assist procurement in stimulating the circular economy?"

Technology has been found to provide multiple effects in assisting in procurement. First, ICT can provide the procurement function with information and insight, on both suppliers and products. With this it can be easier to have an overview of the purchases, and whether they adhere to the set CE procurement policy. Increased insight could also alleviate concerns relating to product quality and lifetime. This insight could also be achieved with the use of technology for supply chain transparency, by providing irrefutable data on e.g. provenance of materials. This technology could also alleviate some of the problems relating to supplier reluctance with sharing information by increasing the collaboration between buyer and supplier. ICT could assist procurement in the establishment of a performance management system, with which can provide data on the effects investments on CE has, both environmental and economical. ICT and tracing technology can alleviate workload in structuring and organising data. Tracing technology could facilitate a multiple supplier

sourcing strategy by providing irrefutable information on the provenance of materials. This could reduce the time and effort required to assess and evaluate possible future suppliers.

Problem statement: "How can a technology driven procurement strategy stimulate the circular economy in the aquaculture industry?"

Resulting from this thesis, it is found that a technology-driven procurement strategy can stimulate the circular economy by enhancing the mechanisms in which procurement stimulates CE. It is seen in the thesis framework that technology has a potential to stimulate the circular economy in both procurement enablers and processes. As stated previously, by using the increased information flow on both suppliers and materials in the value chain, enabled by technological advancements, an actor in the aquaculture industry can more easily make purchases which is in accordance with CE principles. With more detailed specifications enabled by the aforementioned data, a buying organisation can provide sufficient market pull for circular products, and suppliers can thus be stimulated to produce products and enact practises which adhere to these CE principles. Technology for supply chain transparency could provide further collaborative interfaces between buyer and supplier, by sharing information and data to increase CE effects. This collaboration can result in buyers and suppliers aligning interests to reduce the impact that the aquaculture industry has on the environment. However, implementation of technology for supply chain transparency requires sufficient basic technology, such as ICT. Moreover, the implementation should be performed gradually to ensure that the workers are confident in the systems capabilities. Performance management systems could be used to monitor the effects these implementations have on the organisations sustainable operations. These are the mechanisms in which a technology-driven procurement strategy could stimulate the circular economy in the aquaculture industry.

6.2 Further research and limitations

With the use of a narrative literature review, in conjunction with qualitative interviews, we have explored how technology could stimulate the circular economy in the aquaculture industry. However, these methods entail some limitations. The admission of literature with authors invested in CE could provide a view that can be overly optimistic relating to both CE and technology to influence circular procurement. To counter this, the literature on the critiques of CE is added. To further balance the findings from this thesis, research on the cost-aspect of implementing technology to stimulate for CE should be performed. This could possibly include a comprehensive performance management system for measuring environmental impact.

Moreover, while re-certification and extension of lifetime is a large part in CE philosophy, further research on the effect of technology in monitoring and extending lifetime could be of interest to explore. This is especially interesting, as lifetime extension is a crucial point for sustainable business models potential in following CE principles. Further research could thus assist in exploring these topics on how technology could close the loop.

Related to limitations of the thesis, we have with the methods described in section 3 explored the use of technology in procurement to stimulate the circular economy, however, some elements can be discussed. It can possibly be seen as a weakness that there were conducted four interviews. Regarding the three interviews at Grieg Seafood this was, however, deemed to be sufficient to explore the procurement function's potential in stimulating the circular economy. Furthermore, the perceived benefits of technologically driven procurement, as well as the prevailing attitudes the workers in the organisation, were sufficiently illuminated. Further inclusion of available interview subjects from Grieg Seafood would not necessarily be of sufficient

relevance to strengthen the results. However, the admittance of an interview with Flokk could be seen as a mitigation of this issue with validity. This addition required some adjustments, especially in regard to the scope and study case. Nevertheless, these adjustments were deemed acceptable to strengthen the findings and analysis.

The inclusion of different questions posed to the interview subject could possibly have yielded different results. While the ones used in this thesis provided results related to the subject matter at hand, some issues were encountered. During the interviews, it was discovered that some of the questions required further explanation. One question specifically failed to provide an answer as the explanation provided by us was insufficient. By revising the interview guide, it could possibly have provided an answer relating to that specific topic, and the results could be strengthened. However, the inclusion of more questions would not necessarily have been beneficial, as it was stated that the length of the interviews should be around 45 minutes. The duration of the interviews spanned from around 34 minutes to 53 minutes. The admission of additional questions in the interview guide could possibly have increased the length of the interviews to an undesirable level.

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A Interview guide (Norwegian)

A. Bakgrunn

- o Hvilken stilling har du i bedriften?
- o Hvor lenge har du vært i den?
- o Kan du fortelle om en typisk arbeidsdag for deg? Hvilke oppgaver, prosesser ansvar har du?

B. Nå-situasjon

- o Kan du i grove trekk beskrive deres nåværende innkjøpsstrategi?
- o Kan du beskrive hvordan dere i dag samhandler med deres leverandører? F.eks e-post, ERP systemer, etc.
 - i. Har du tidligere opplevd noen problemer knyttet til denne samhandlingen, f.eks mangel på, eller tilbakeholdelse av informasjon, etc.
- o Kan du beskrive deres tilgang på produktinformasjon i verdikjeden?
 - i. Opplever dere utfordringer knyttet til materialflyten i deres verdikjede? Er det usikkerhet på mengde? Kvalitet? Av råvarer
- o Kan du beskrive hvordan dagens situasjon er i din bedrift når det kommer til anskaffelser av resirkulerte produkter/komponenter?
 - i. Hvordan opplever du tilgangen og etterspørselen?
- o Hvordan vet dere i dag om hvorvidt et produkt skal forbli i verdikjeden?

C. Sirkulær økonomi

- o Kan du fortelle hva du legger i ordet sirkulær økonomi?
- o Vektlegges prinsippene fra sirkulær økonomi (eliminere waste og forurensing, sirkulere produkter og materialer, gjenopprette naturen) i dagens anskaffelser av produkter eller komponenter?
- o Kan du fortelle om noen opplevelser knyttet til utfordringer innen sirkulære innkjøp, f.eks svak dokumentasjon på opprinnelse, dårlig kvalitet på produktet etc.
- o Kan du fortelle om hvordan du anser verdien for verdikjeden av å anskaffe resirkulerte produkter/komponenter?

D. Bruk av teknologi i innkjøp

- o Kan du beskrive hvordan teknologi i innkjøpsavdelingen anvendes i dag for å forbedre den sirkulære verdikjeden?
- o Har det vært noen utfordringer knyttet til bruken av dette?

E. Ønsket situasjon

- o Hva tror du er innkjøps rolle i overgangen mot sirkulærøkonomien?
- o Hvordan vil, i dine øyne, en innkjøpsstrategi bygget på økt bærekraft påvirke deres konkurransedyktighet?
- o Hvordan tenker du ny teknologi (som sporingsteknologi) kan påvirke bedriften til å gjøre det lettere for bedriften å anskaffe og ta i bruk resirkulert materiale?
 - i. Har du noen tanker om konstansaspektet ved innførelsen av ny teknologi for sirkulærøkonomi?

F. Avsluttende

- o Er det noen andre ting vi ikke har snakket om som du tror er relevant når det gjelder bruk av teknologi til å stimulere sirkulærøkonomien?
- o Har du noen generelle kommentarer?
- o Vet du om noen andre som kunne vært relevante for oss å intervjuer?
- o Er det greit om vi kan kontakte deg igjen hvis vi trenger noen utdypninger?



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