TCO-tools – a supporting tool for public organisations in the transition towards circular public procurement

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Abstract:

Current research on barrier and enablers for CPP using existing GPP and SPP tools to support CPP. In Denmark have the TCO-tools developed by the Danish EPA been highlighted in this discussion. However, a low uptake of the tools and potential limitations of present tools for CPP make it interesting to explore and understand whether the Danish EPA's approaches are enough to ensure that the tools can support CPP in theory and practice. It leads to this research question;

What is the potential of the Danish Environmental Agency's TCO-tools to support Circular Public Procurement?

To answer the research question the TCO-tools are analysed using an analytical framework based on the R-framework developed by Potting et al. (2017), semi-structured interviews, and a webinar on the TCO-tools. Whereas a case study of Danish Regions, including 4 semi-structured interviews, is used to understand TCO-tools in practice for CPP.
It is concluded if the TCO-tools are to support Circular Public Procurement it highly depends on whether or not that the right conditions are established in the Public Organisation. Theoretically, the TCO-tools could support CPP, but in practice it depends on whether the organisation can align its policies, strategies, and practices with a total cost of ownership perspective and allocate the needed resources.

Dansk resume

Offentlige indkøb er anset, som værende en af hovedaktørerne i skiftet fra en lineær til cirkulær model. Nuværende litteratur peger dog på, at det stadig er på et begyndende stadie, hvilket blandt andet skyldes manglende brugbare værktøjer. Dette studie tager udgangspunkt i at undersøge de danske TCO-værktøjer udviklet af Miljøstyrelsen og deres brug for offentlige cirkulære indkøb. Dette er baseret på, at både regeringen, men også studier peger på at nuværende værktøjer for grønne offentlige indkøb kan udvikles til at inkludere cirkulære principper. Værktøjerne er undersøgt både fra en teoretisk og praktisk vinkel med følgende problemstilling;

Hvad er potentialet af Miljøstyrelsens TCO-værktøjer for at understøtte cirkulære offentlige indkøb?

Problemstillingen er besvaret gennem to delanalyser, hvor den første tager udgangspunkt i potentialet af TCO-værktøjer til at understøtte cirkulær økonomi fra en teoretisk vinkel. Til det er et R-framework brugt til at forstå hvordan TCO-værktøjerne understøtter R-strategierne; refuse, rethink, reduce, reuse, repair, refurbish, remanufacturing, repurpose, recycle og recover. Ud fra analysen bliver det konkluderet, at TCO-værktøjerne understøtter flere R-strategier i varierende grad. Det bliver også konkluderet at når man bevæger sig mod kommende TCO-værktøjer, så kan cirkularitet i højere grad understøttes. Den anden analysedel tager udgangspunkt i den praktiske del af potentialet af TCO-værktøjerne. Til det er et casestudie af de danske regioner lavet, hvor semi-strukturerede interviews med respondenter fra regionerne er kodet for at forstå de barrierer og drivere, der er ved at optage TCO-værktøjerne. Konklusionen på den analyse er, at hvis TCO-værktøjerne skal understøtte cirkulære offentlige indkøb, så er det en forudsætning at de rette konditioner er etableret i de offentlige institutioner. Samlet set er konklusionen at teoretisk set, så kan TCO-værktøjer godt understøtte cirkulære offentlige indkøb, men i praksis, så afhænger det er om organisationerne kan justere deres politikker, strategier og arbejdsgange til et TCO-perspektiv og allokere de nødvendige ressourcer. Ud fra de to analyser er der givet nogle anbefalinger til både regionerne og Miljøstyrelsen.

Preface

This thesis was carried out at Aalborg University during the my last and fourth semester of the Environmental Management and Sustainability Science Master's degree over the period beginning on September 1st 2022 and ending on January 6th 2023.

Acknowledgements

Given the nature of this thesis, the collecting of data has heavily relied on empirical data, which has been essential for generating this report. As a result, I would want to express my gratitude to each and every one of the 6 interview respondents for taking their time to participate in an interview.

In addition, I will also like to express my utmost gratitude to my supervisor, Heidi Simone Kristensen, for providing me with encouraging feedback and direction throughout the duration of my thesis. In closing, I would want to express my gratitude to my loved ones for the continuous encouragement they have shown me during this thesis.

Reading instructions

The citations in this paper adhere to the Harvard reference style. The entire list of citations can be found at the conclusion of the study. Tables and figures are labelled according to their placement in the chapter. For this research, interviews with Danish respondents were conducted; consequently, the interviews were done in Danish. Therefore, the quotes used have been translated into English which also includes that certain Danish terms have been modified to make sense in English.

5/1-23

Maiken Høvring

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The transition to a Circular Economy 1

Current production and consumption patterns can be described as a linear "take-make-use-dispose" economic model (Klein et al., 2020). It includes that products are made from raw materials, then sold, used, and discarded as waste (Ellen MacArhtur Foundation, 2015). A such model functions as long as it will be able to supply the next generation as equally well as the previous while not affecting vital ecosystems (Arler et al., 2015:p.29).

It is however not the case in today's society as population growth, increasing middle class and environmentally polluting production systems have put significant pressure on the resources. The negative effects on the environment and society of the current model have been on the political agenda since the 1960s. Organisations and politicians have been working on resource efficiency as well as reducing environmental impacts through cleaner production and products in decades (ibid.:p.169-194). However, such improvements will only postpone the inevitable as a model built upon consumption cannot prevent significant losses of resources. A new model based on the restorative use of materials is therefore needed (Ellen MacArhtur Foundation, 2015).

The concept of circular economy (CE) is gaining popularity among not only academics and businesses, but also policymakers, as it rethinks the present unsustainable linear "take-make-use-dispose" paradigm (Klein et al., 2020; European Commission, 2015). In general, CE rethinks the linear model by being restorative of nature and seeking to keep resources in circulation for as long as possible (Ellen MacArhtur Foundation, 2015). The goal is to maintain the value of resources, products and materials while minimising the generation of waste (Europaen Commission, 2017; Geissdoerfer et al., 2017; Ellen MacArhtur Foundation, 2013).

There is currently no clear and common definition of CE, but it is agreed in more recent literature that such a definition should define CE as a concept that aims to achieve sustainable development through new business models that replaces the current disposal and end-of-life concept in the linear model by enabling and creating resource loops drawn on dimensions of the waste hierarchy. It

operates at several levels (micro, meso and macro) implying a system perspective (Kirchherr et al., 2017; Nobre & Tavares, 2021)

The focus in CE is on decreasing the input of resources to the economic system as well as reducing waste by centering the circularity of resources. This can be achieved by creating and managing resource loops. In 2016 Bocken et al. (2016) introduced the terminology narrowing, slowing, and closing, that sums up CE in three different management strategies. The first mentioned refers to resource efficiency entailing that fewer resources enter the economic system. It relates both to reducing the absolute resource consumption and the used resources in the manufacturing, distribution, or use phase of products. The next; slowing is more centered on how the product can stay in the system by extending its lifetime. The last one refers to closing the system and thereby not letting the resources leave the economical system.

The terminology derives from previous research on resource loops and approaches for reducing the consumption of resources as well as the production of waste. These approaches are often referred to as R-strategies derived from waste treatment methods. Several lists and frameworks exist applying various strategies (Kirchherr et al., 2017). For this thesis, the R-framework developed by Potting et al. (2017) covering 10 different strategies have been chosen. These are summed up in fig. 1.1 together with the terminology by Bocken et al. (2016).

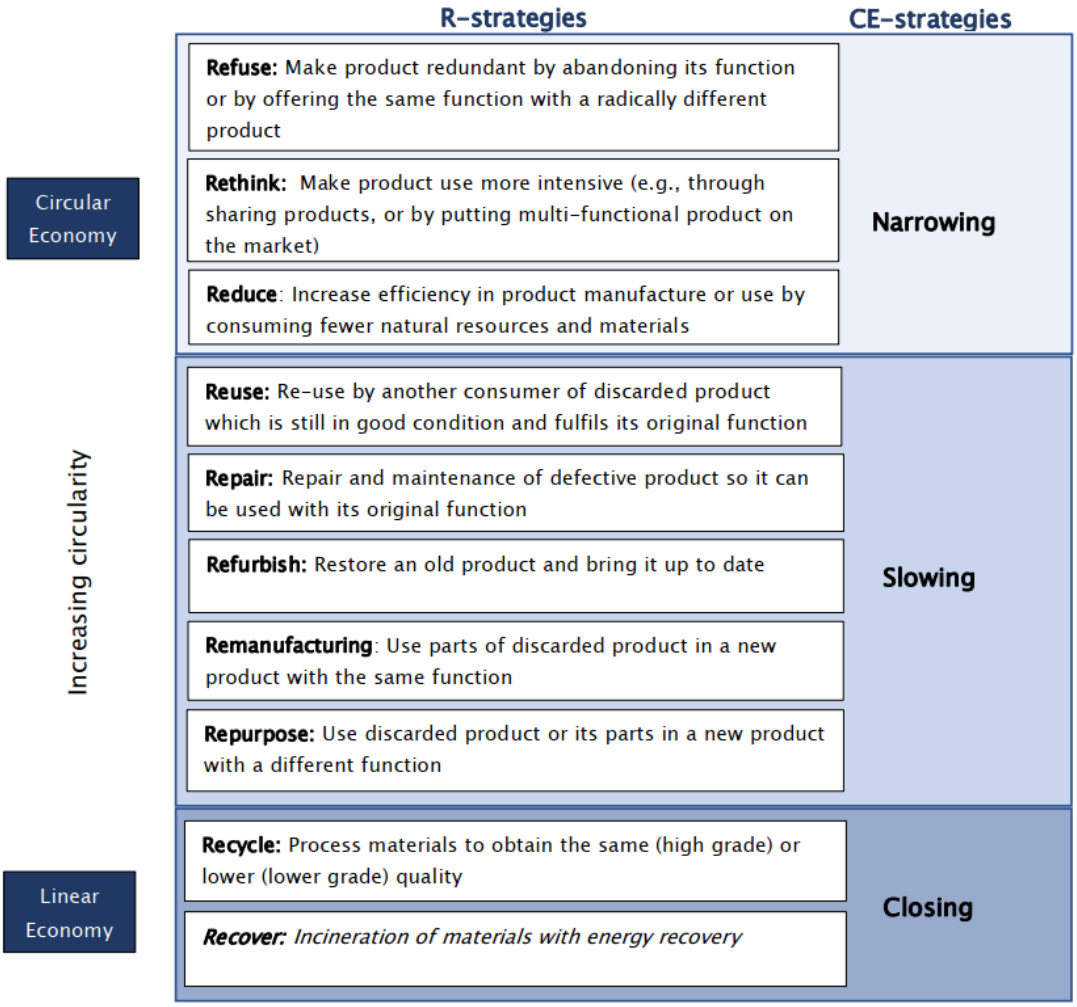


Figure 1.1 A visualisation of the approaches and strategies for transition from a linear to a circular economy. Own illustration inspired by (Potting et al., 2017; Bocken et al., 2016).

Notable here is that they should not be viewed as equal opportunities, but a hierarchical approach should be applied based on the intensity of the circularity. This is also illustrated by the numbers in the list above. The rationale behind this is that resources, products, and materials should be kept as close to their original state for as long as possible to maintain the highest value (Ellen MacArhtur Foundation, 2013). It is emphasised by (Potting et al., 2017; Reike et al., 2018) that *refuse* and *reduce* are crucial strategies as despite resource circulation being important, a reduction in resource consumption is preferable. *Refuse* implies that the resource never enters the system, resulting in an absolute reduction in resource consumption, whereas *reduce* focuses on minimising the number of resources used in the manufacturing, distribution, or use phase (Figge et al., 2014). Furthermore, it is argued that the strategies should be considered and incorporated into the design phase in order for products to enter these resource cycles. This can include long-lasting materials without any chemicals or a design that allows for extend-

ing the life of the product through e.g. the strategies *repair* and *remanufacture* (Kirchherr et al., 2017). *Recycling* and *recover* should be seen as a last resort, as *recycling* often results in down-cycling entailing reducing the quality and value of the material. Where *recover* results in that the materials are no longer available for re-entering in a new product (Kirchherr et al., 2017; Bocken et al., 2016).

Transitioning to a circular economy necessitates multi-level change that includes not just technological innovations but also stakeholder collaboration and new business models. It is not viable to rely solely on new product designs in a circular economy since it would need the creation of recycling infrastructure and service support to keep resources in loops. In general CE business models are often radically different from current models requiring new habits for consumers (Alhola et al., 2018). To promote the transition to a circular economy, Public procurement (PP) has been given special attention by the EU. Around 14% of the European GDP is accounted for through PP giving a significant opportunity to promote and stimulate the transition by among others creating new markets and asking for innovative solutions (Europaen Commission, 2017; European Commission, 2015).

1.1 Public procurement for a circular economy

In general, PP can be defined as the *"acquisition of goods and services by government or public sector organisations"* (Uyarra et al., 2014:p.632). The implementation and integration of CE in procurement are yet still at an emerging stage (Sönnichsen & Clement, 2020). However, strategically utilising PP to achieve political agendas is not a new approach in the EU, as especially Green Public Procurement (GPP) can be viewed as a more institutional policy (Morales, 2021; Kristensen et al., 2019).

In practice utilising PP to achieve a political agenda requires a change of business as usual as the function of PP would need to move from just providing the end-users with goods and services to complete their tasks to also achieve these so-called horizontal policy objectives. This entails that the purchaser is taking these objectives into consideration when purchasing. Such an approach enables the purchasers to buy goods and services not only for their immediate advantages but also for a variety of secondary advantages (Arrowsmith, 2010). For example for GPP the horizontal objectives are environmental, entailing that requirements are set for the environmental properties of the product or service. Circular Public Procurement (CPP) compared to GPP is relatively new as it was first adopted by the EU in 2017, whereas GPP has existed for more than a decade, which is also

visible in practice as CPP is still at a nascent stage (Europaen Commission, 2017; Sönnichsen & Clement, 2020).

It is argued by Alhola et al., 2018 and Kristensen et al., 2021 that a present low uptake of CPP among others relates to a lack of common understanding of what it entails as it is argued to differ significantly from the more widespread terms GPP and Sustainable Public Procurement (SPP). This also entails a lack of competencies, guidance, and tools (Sönnichsen & Clement, 2020; Kristensen et al., 2021). To fully exploit and understand the concept of CPP and why it differs significantly from current procurement processes it is in the following described in relation to the other approaches to PP and explained through connected strategies and principles.

1.2 Circular Public Procurement

GPP is by the EU defined as

> A process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle compared to goods, services and works with the same primary function that would otherwise be procured.
>
> (European Commission, 2016:p.4)

This approach to PP is mainly focused on the environmental aspects of the product. Implying the use of environmental criteria in the procurement such as energy efficiency, emissions intensity, eco-labels, noise thresholds, and environmental management systems (Rainville, 2017).

SPP can be seen as an extension of GPP as it includes the two other pillars of sustainability. It is defined as

> A process by which public authorities seek to achieve the appropriate balance between the three pillars of sustainable development - economic, social, and environmental - when procuring goods, services, or works at all stages of the project..
>
> (European Commission, n.d.)

Despite GPP often being used as a synonym for SPP, SPP differs as it is more explicit in the inclusion of economic and social aspects (UNEP, 2021). However, in practice the social aspect is often included through GPP criteria and not as an explicit process (Andrecka, 2017).

Lastly, CPP can be defined as

> The process by which public authorities purchase works, goods or services that seek to contribute to closed energy and material loops within supply chains, whilst minimising, and in the best case avoiding, negative environmental impacts and waste creation across their whole life-cycle.
>
> (Europaen Commission, 2017:p.5)

It can be viewed as a modernisation of SPP and GPP. It differs in practice as the focus is no longer only on environmental-friendly materials, but on reuse, repair, remanufacture, recycling, etc (Qazi & Appolloni, 2022). The focus is on zero-waste, which is not necessarily the case for GPP and SPP, and doing so requires a whole new way of thinking about the needs, processes, and organisations (Alhola et al., 2018; Kristensen et al., 2021; Witjes & Lozano, 2016).

CPP can be implemented in three different levels which include a system level perspective, a supplier level, or a product level (Jones et al., 2017; Europaen Commission, 2017).

- On a product level it is centered around circularity of the purchased product. This includes setting requirements for the product in relation to the inclusion of recycled materials, resource efficiency, materials that can be recycled, design for disassembly etc.
- On a supplier level it relates to the suppliers and how they can ensure the circularity of the product. This can include internal or external reuse or resale of the product, design for disassembly, repairability, and supplier take-back systems.
- The last one, system level refers to contractual methods, and the product is more seen as a service, which includes take-back systems, sharing, product-service systems, public-private partnerships, and rental or leasing.

1.2.1 Circular Procurement in Practice

According to the guidance on *Public procurement for a circular economy* published by the EU in 2017, integrating the CE in procurement starts with considering if the needs could be fulfilled in other ways than purchasing the product. This can include an understanding of the function needed instead of focusing on the product. Such an approach would allow for understanding whether already existing resources are available within the organisation or whether they could be purchased as a service. If not and a purchase is necessary, a way to prioritise potential actions could be through utilising a procurement hierarchy based upon the waste hierarchy: reduce, reuse, recycle etc. (Europaen Commission, 2017).

This often includes a market dialogue to understand what is currently available, but also currently possible for potential suppliers. After this has been converted into requirements, the award criteria must be considered. According to the EU Directive on Public Procurement all contracts must be awarded on the basis of most economically advantageous tender (MEAT), this can be based upon either;

- Lowest price or
- Lowest cost or
- Best price-quality ratio

Using **Best price-quality ratio** including life-cycle costing is preferable for CPP. It would allow for products that might be more expensive in purchasing price, but lower in the total costs to be considered which is often the case for circular products. Furthermore, the additional criteria should also weight circularity high which can be done by for example through asking for recycled materials, or that the product will be reused when returned to the suppliers (Forum for bæredygtige indkøb, 2017).

Despite that the practices are changing when moving from GPP and SPP to CPP, GPP and SPP are still promoted as a tool for the transition to the circular economy (Alhola et al., 2018). Current tools available for GPP and SPP to some degree already introduce some circularity in PP. This includes among others the GPP criteria from EU as well as Ecolabels (Europaen Parliament, 2017; Alhola et al., 2018). Moreover, life-cycle thinking tools such as life-cycle assessment (LCA) and life-cycle costing (LCC) have also been highlighted in the literature as useful in relation to evaluating services and products and selecting suppliers. By helping the procurer to understand the cost of the product or service, as well as the embedded impacts and emissions (Sönnichsen & Clement, 2020; Klein et al., 2020). The European Parliament (EP) have also encouraged that in order to transition to CE current knowledge on GPP could be combined with circular principles (Europaen Parliament, 2017). This also include that the development of tools is crucial for the transition as some of the main barriers for GPP have been the lack of tools. (Kristensen et al., 2021) also recommends that national governments should seek to include CE principles in already existing and used tools. A similar approach is also utilised in Denmark for the transition to the circular economy.

The Danish Government highlighted in their strategy for the circular economy published in 2018 among others need to strengthen the inclusion of Total Cost

of Ownership (TCO) in the decision basis for public procurement (Ministry of Environment and Ministry of Food, Agriculture and Fisheries of Denmark Food and Ministry of Industry, Business and Financial Affairs, 2018). This includes as highlighted in the appurtenant action plan from 2021 a development of already existing TCO-tools by the Danish Environmental Protection Agency (EPA) as well as seeking to extend the uptake of the tools through legislation. Moreover, to make them more user-friendly by making a digital version compared to their current version of excel-spreadsheets (Ministry of Environment, 2021). This approach is interesting as some gaps and challenges exist in the current available TCO-tools for utilising the tools for circular procurement. These challenges will be highlighted in the next section, but first, the tools are briefly described to give an understanding of them.

1.3 TCO-tools from the Danish EPA

The current TCO-tools from the Danish EPA are in their simple form a spreadsheet where the purchaser calculates the total cost of products or services and then compares them against each other based on data received from the bidders. They are made available and free of charge for all on the platform "The Responsible Purchaser" where an appurtenant guide for the tools also can be found (Den ansvarlige indkøber, n.d.). The tools are product-specific and currently available for 26 product categories [1].

The calculation of the costs is based on the following equations. "TCO organisation" refers to the costs for the organisation of acquiring the product without any consideration to externalities of the acquisition.

> **TCO organisation** = Investment + (operational cost x usage pattern x energy prices + service/leasing-payments) x year - costs for end of life

[1] Lighting, Blast cabinets, Computers, Condenser Units, Refrigerators/ Freezers (Household), Refrigerators/ Freezers (Industrial), Small Network Equipment, Motor vehicles (Operational leasing), Motor vehicles (Purchase or financial leasing), Multifunction machines, Dishwasher (Household), Dishwasher (Industrial), Oven (Household), Oven (Industrial), Projectors, Self-service machines, Servers, Flushing toilets, Screens, Storage equipment, Large Network Equipment, Uninterruptible Power Supply, Washing machines (Household), Washing machines (Industrial), transport services (Den ansvarlige indkøber, n.d.)

TCO organisation incl. socio-economic environmental costs = TCO organisation + operational costs x usage pattern x year x emission factor x socio-economic cost factor

In general, TCO consists of the purchasing price as well as the associated cost including delivery, installation, insurance, etc. Moreover, it also covers the operating costs such as fuel, energy, water use, and any cost related to maintenance and spare parts as well as the end-of-life cost which is e.g. disposal, resale, or decommissioning in case of services (DS - Dansk Standard, 2017). The tools by the Danish EPA do however go beyond this by including some cost of the environmental and social externalities. This includes measurable resources such as the amount of energy, fuel, and water used in the use phase. As illustrated by the equation above this is then multiplied by an emission factor which can be the standard emission included in the TCO or the organisation's own standard. The tools currently include accepted standards from either national or international organisations (see further explanation in chapter 4).

The tools can be used in different stages of the procurement cycle. In the preparation stage of the tender, which often includes a market dialogue and a dialogue with the users, it can be useful to consider the additional costs that might be related to some services or products compared to others. It can also be used to determine whether some business models might be preferable to others based on the costs as well as whether there might be some additional requirements that could be relevant based on the initial cost analysis. The spreadsheets are not locked, entailing the purchaser can add additional relevant costs themselves or exclude some of the existing cells.

It is possible to include TCO as the determining factor in the award of the contracts by basing it only on the lowest cost. However, such an approach does not allow for the inclusion of additional requirements which can be done by using the best price-quality ratio, where the TCO is a part of the award criteria. Including TCO in the procurement process gives some additional tasks for the purchaser as they will need to specify the required data needed from the suppliers as well as collect information from the end-users (The Danish EPA, Officer, 2022; Viegand and Maagøe, 2022).

1.3.1 Challenges of current TCO-tools

The current tools only include the environmental impacts that are measurable during the use phase (energy, water, fuel) which exclude the environmental impacts from production and end-of-life treatment. It is therefore not currently possible to understand whether a more circular business model is also more environmental-friendly as the life-cycle perspective is missing. This is crucial as the circularity of products should only be introduced to such an extent that it is still good for both society and the environment (Alhola et al., 2018; Nobre & Tavares, 2021). One of the main reasons for the lack of a life-cycle perspective is The Public Procurement Act as well as the EU Directive on Public Procurement. The Directive states the following for including environmental aspects in life cycle costing in tenders;

> The method used for the assessment of costs imputed to environmental externalises shall fulfill all of the following conditions:
>
> 1. it is based on objectively verifiable and non-discriminatory criteria. In particular, where it has not been established for repeated or continuous application, it shall not unduly favour or disadvantage certain economic operators;
> 2. it is accessible to all interested parties;
> 3. the data required can be provided with reasonable effort by normally diligent economic operators, including economic operators from third countries party to the GPA or other international agreements by which the Union is bound.
>
> .
>
> (EUR-Lex, 2014:Article 68)

The first condition currently hinders the inclusion of several environmental impacts in the current TCO-tools as there currently are very few standards on how to calculate several environmental impacts in such a way that it allows them to be verified to ensure a fair comparison. This among others includes that impacts from production and end-of-life currently can not be included in the TCO-tools as well as e.g. some emissions from chemicals during the whole life-cycle including the use phase unless a standard is available. In addition, the current tools are only available for energy-related products limiting the application. The rationale behind this is that they all have a high resource use in the use-phase making them relevant to view from a total cost of ownership perspective. This, as products with low resource use, will result in a lower operational cost and thereby influence the total cost. More resource-efficiency products with a higher purchasing price are often cheaper from a total cost perspective compared to less

resource-efficiency products with a low purchasing price. Moving beyond just focusing on energy usage could therefore be more complex as well as making TCO relevant for other product areas than energy-related products (Viegand and Maagøe, 2022). Another challenge could be that the current tools rely on the purchaser's competencies and resources which as highlighted by Kristensen et al. (2021) and Qazi & Appolloni (2022) could be crucial as they often are not there yet. There is currently no way to measure the uptake of the tools however, a report from The Danish Competition and Consumer Authority indicated a low uptake as only 3,5 % of the analysed 2020 EU-tenders included TCO (The Danish Competition and Consumer Authority, 2021). A higher uptake is expected in the following year as governmental organisations will be obligated to consider TCO when they purchase, as well as use the available tools by the Danish EPA (Civilstyrelsen, n.d.). The regulation does however not cover either municipalities or regions entailing a still continuously voluntary approach for more than 87% (~263 billion DKK) of the total yearly spend by the public sector (300 billion DKK) (The Danish EPA, 2020).

Research Question 2

PP is considered to have an essential role in the transition from current unsustainable production and consumption patterns to the CE. CPP is focused on zero waste by seeking to close energy and materials loops centralising the CE strategies; reuse, reduce, repair, etc. However, the integration of CE in procurement is still at an emerging stage which concluded from the initial analysis of this thesis among others is a result of a current lack of relevant and useful tools. It is suggested that already available tools for GPP and SPP could be further developed to include circular principles to increase CPP. The Danish government is taking a similar approach by seeking to increase the uptake of the TCO-tools developed by the Danish EPA as well as further developing these. However, the current low uptake of the tools and potential limitations of current tools in regard to CPP makes it interesting to investigate and understand whether the approaches from the Danish EPA are enough to ensure that the tools are applicable for CPP both in theory and in practice. It leads to the following research question;

Research Question:

What is the potential of the Danish Environmental Protection Agency's TCO-tools to support Circular Public Procurement?

Sub-Questions:

- Which circular strategies are supported by the TCO-tools and how?
- What are the current barriers and drivers for adopting the TCO-tools for Circular Procurement in practice?
- How could the TCO-tools further support Circular Public Procurement?

Research Design and Methods 3

This chapter presents the research design and methods applied in this thesis. It includes the scientific considerations of the research and the qualitative methods used for answering the research question and sub-questions as presented in chapter 2. Therefore, this chapter aims at providing transparency of the scientific and methodological choices of this research.

3.1 Research Design

The research design for this thesis is illustrated on fig. 3.1. The thesis follows an abductive process entailing a combination of an inductive and a deductive approach (Brooks, 2013). The process of this research started by having no theoretical starting point for the collection of data and empirical material. However, as illustrated on fig. 3.1, the initial analysis in chapter 1 led to emerging concepts of the barriers and drivers for a transition to a Circular Economy (CE) through Public Procurement (PP). This led to an observation, that there is a need for relevant tools to support circular public procurement (CPP). This observation started a wonder, if TCO could support this lack of useful tools for CPP and whether the TCO-tools from the Danish Environmental Protection Agency are enough to support CPP. Therefore, the research question was defined as: *What is the potential of the Danish Environmental Agency's TCO-tools to support Circular Public Procurement?*.

As illustrated in fig. 3.1, the subsequently process of the research is determined by the research question and sub-questions. The research question is answered by concentrating the further research on the three sub-questions: Sub-question 1 is used for the first analysis, where TCO in theory is analysed. This is analysed from preceding knowledge on purchasing from the highest level of circularity and the R-strategies presented in fig. 1.1, Chapter 1. However, in order to answer sub-question 1 it was necessary to gain new knowledge on the TCO-tools, in order to answer which circular strategies that are supported by them and how. Therefore, empirical material derived from a webinar and interviews was used for this.

Sub-question 2 is used for the second analysis, where TCO in practice is analysed from a case study of four of the five regions in Denmark. The third sub-question depends on the findings from sub-question 1 and 2, as sub-question 3 combines the findings into recommendations on how the TCO-tools could further support CPP - both in theory and practice.

Finally the findings and methological choices from answering the three sub-questions, and thereby the research question, are being discussed and concluded in the end of the research.

Moreover, as this research is seeking to explore a current research gap it follows an exploratory research approach. This provides for a more flexible study design and allows the researcher to examine the research field from a more open perspective in order to gather empirical information (Creswell, 2014).

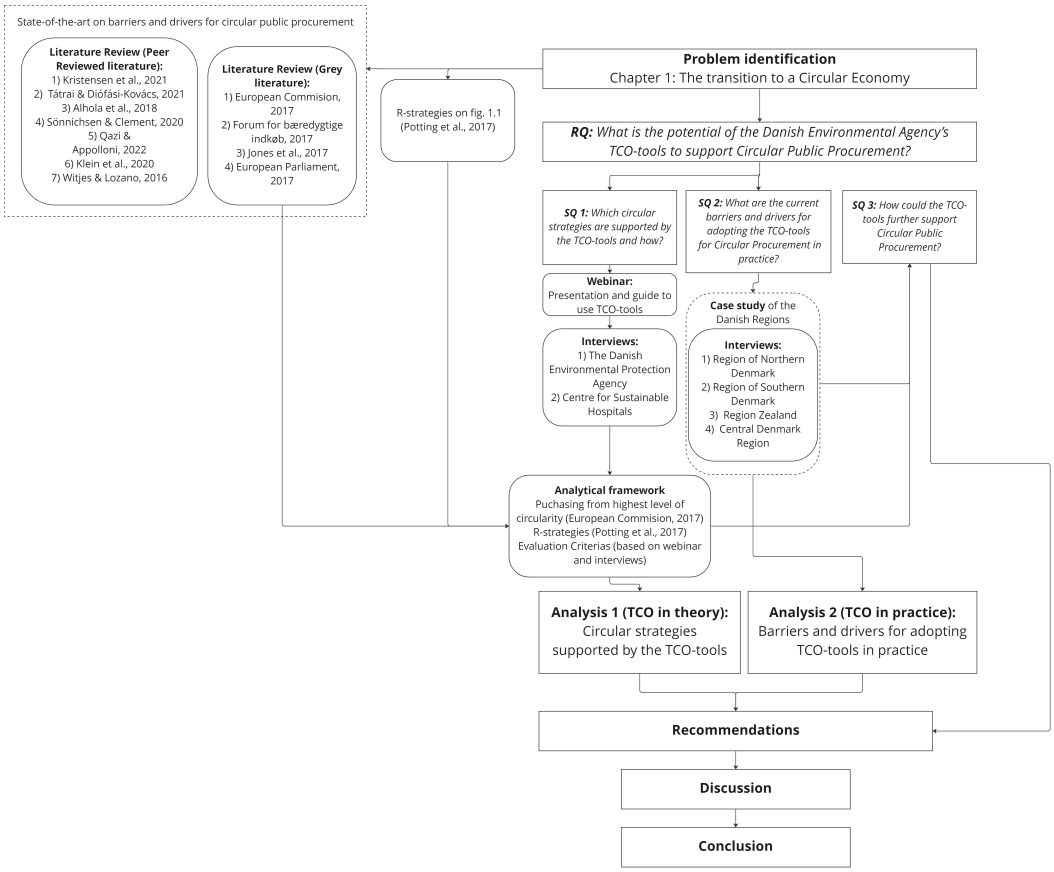


Figure 3.1 A visualisation of the methodology used for answering the research question.

Qualitative methods are applied in order to answer the research question and sub-questions. The use of qualitative methods is reflected in the philosophy of science of this research. Answering the research question highly depends on people's perception of the TCO-tools which can be linked to the definition of social constructivism. Social constructivism emerge from the fact that phenomena exist

from people's constructed knowledge about the phenomena. It is the practices in people's lives that shape the perception of the concepts and activities related to the practices (Burr, 2015). This is especially relevant for this research, as this research investigates what the potential of the TCO-tools is to support CPP. This question cannot be answered without people's knowledge and experiences on which barriers and drivers that affect the adoption of the TCO-tools for CPP in practice. Therefore, the ontological position of this thesis is social constructivism.

3.2 Case study

To answer the research question, it is relevant to focus on public organisations as they are executing public procurement and are given authority to use the TCO-tools. To make a deep investigation of the drivers and barriers of adopting the TCO-tools, a case study has been made for this research. The case study allows for gaining insight of the practices through the perspectives and experiences of the persons who work with public procurement in their every day lives. Therefore, doing a case study can be advantageous since it provides a more deep knowledge of social phenomena and circumstances (Flyvbjerg, 2006; Robert K. Yin, 2009). Including public organisations as the case study can also be beneficial in relation to obtaining a more nuanced and valuable discussion for understanding the potential of the TCO-tools for CPP.

For this thesis, the Danish regions are chosen as the specific case that reflect one of the danish public organisations. The reason for choosing the regions, is the large potential for reducing the environmental impacts of the healthcare sector through adjustments in the procurement processes; in Denmark the healthcare sector stands for approximately 6 % of the national greenhouse gas emissions, and 71 % of their emissions can be accounted to their supply chain, which relates to the procurement of goods and services (Karliner & Slotterback, 2019; Health Care without Harm, n.d).

Moreover, in the initial phase of this research it was discovered that the Danish EPA is currently collaborating with the Central Region Denmark on developing a new TCO-tool for hospital textiles which will be published at the beginning of 2023. Choosing the Danish regions would therefore also allow an understanding of whether or not the Danish EPA with its current developments of TCO-tools increases the potential of the tools to support CPP or not.

It can therefore also be discussed that the case selection has been an information-oriented selection, as the initial research led to the case (Flyvbjerg,

2006). The case study adheres to the single-holistic case design introduced by Robert K. Yin (2009). This entail that one unit of analysis is included in the research, which for this thesis consists of understanding the TCO-tools in practice at the Danish Regions. As the rationale behind the choice of the regions is based upon investigating and including the current developments of the Danish EPA to understand its potentials for CPP, it can therefore be viewed as a critical case.

3.2.1 The Danish regions

In 2007 Denmark was divided into five regions after a structural reform that abolished 14 counties. Each region is responsible for running the health care and the underlying services with economical support from the danish state. The invention of the five regions should ensure a more coherent health care (Regioner, 2019). The Danish regions, listed in ascending size based on the number of citizens in brackets, are:

- Capital Region of Denmark (1,846,023)
- Central Denmark Region (1,326,340)
- Region of Southern Denmark (1,223,105)
- Region Zealand (837,359)
- Region of Northern Denmark (589,936)

The regions have together a total purchase quantity of around 40 billion DKK. The amount consists of 22 billion DKK to services, 10.5 billion DKK to goods, and 7.5 billion DKK to medicine (Regioner, 2020). It constitute of approximately 13 % of the total spent by public organisations.

The regions have a common purchasing agreement called RFI (Regionernes Fælles Indkøb) which was established in 2014. The agreement is organised in a model where the regions cooperate in category management, joint tenders, projects, and data sharing. In their newest strategy from 2020, it is stated they have focused on value-based purchasing where a more expensive yet sustainable product can save costs in the long run. This is relevant in the discussion of the TCO-tools, as utilising the tools could be applied to calculate and ensure savings. Furthermore, it is also mentioned that the regions should have the security of getting supplied critical goods (ibid.). This could be viewed as an incentive for introducing and increasing CPP to ensure a continuous supply by keeping the resources in loops.

All of the five regions were contacted with the purpose of conducting interviews in order to gain insight of their use of the TCO-tools for CPP. However, only four

out of five regions responded and agreed to do interviews. This includes; Region of Northern Denmark, Region of Southern Denmark, Region Zealand, Central Denmark Region. The Capital Region of Denmark is therefore not included in this thesis.

3.3 Methods for data collection

As visualised on fig. 3.1 several methods have been utilised to collect data for answering the research question. It covers; participating in a webinar, semi-structured interviews, and literature review. They are all presented and described in the following sections.

3.3.1 Participating in a webinar

To gain knowledge of the TCO-tools it was decided to participate in a webinar on how to use the TCO-tools. The webinar was held by the consulting company Viegand and Maagøe on the 20th of September 2022 on behalf of the Danish EPA. In addition to organising the webinars, Viegand and Maagøe also assist the Danish EPA in developing the TCO-tools.

The webinar consisted of both a presentation of the tools as well as an exercise to get hands-on experience with the current available TCO-tools. Prior to the webinar the slideshow from the webinar as well as the TCO-tools that were to be used during the exercise was sent by email. The attached TCO-tools were completed with some random numbers given as examples of how they can be used.

The attendants were a mix of students, purchasers, and consultant companies with an interest in understanding the tools. As the webinar was a part of the initiating phase of this research it also give insight into the current development of the TCO-tools including the ongoing collaboration between the Central Region of Denmark and the Danish EPA to develop a new TCO-tool as mentioned in section 3.2.

3.3.2 Semi-structured interviews

In order for answering the research question six interviews have been conducted. The interviews have all been conducted from a semi-structured approach based on an interview guide. An overview of the conducted interviews is given in table 3.1. The first interview is with the Danish Environmental Protection Agency where the last five interviews are with respondents from the regions.

Date	Organisation	Respondents	Duration	Rationale
30/09/2022	The Danish Environmental Protection Agency	Officer, responsible for the development of TCO-tools	52:50 min	Understanding TCO-tools in theory
10/10/2022	Centre for Sustainable Hospitals (Central Denmark Region)	Project leader on developing the tool for hospital textiles in Central Denmark Region	43:32 min	Understanding TCO-tools in theory
12/10/2022	Region of Northern Denmark	a Sustainability (Climate) Consultant and a Tender Consultant	54:56 min	Understanding TCO-tools in practice
14/10/2022	Region of Southern Denmark	Sustainable Procurement Consultant	30:31 min	Understanding TCO-tools in practice
25/10/2022	Region Zealand	Tender Consultant	40:30 min	Understanding TCO-tools in practice
30/11/2022	Central Denmark Region	Sustainable Procurement Consultant	37:31 min	Understanding TCO-tools in practice

Table 3.1 An overview of the conducted interviews including the rationale for the respondents as well as an understanding of the information gathered during the interviews.

The respondents are made anonymous but are still described by their job title and which organisation they represent. The interviews were conducted online on Teams in Danish. This means that the quotations used in the thesis are translated. They have been translated in such a way that the opinion and argumentation are maintained but still make sense as some danish formulations cannot be directly translated.

Conducting the interviews from a semi-structured approach allows for interaction between the interviewer and the respondent. It also gives the opportunity for the interviewer to ask additional clarifying questions (Brinkmann & Tanggaard, 2015). The second part of this study is seeking to cover a yet unexplored research field of the utilisation of the TCO-tools in practice for CPP in Denmark. In such case, using qualitative interview as method is beneficial

as it allows for in-depth exploration of the research field by utilising people's experiences of the subject in practice (Bryman, 2012).

Interviews for understanding the TCO-tools in theory

To answer sub-question 1 it was deemed relevant to conduct an interview with one from the department in the Danish EPA that is a part of developing the TCO-tools. This is to understand the rationale behind their current tools as well as to gain insight into the new tool. Furthermore, the reason is also to investigate what they expect to develop in the nearest future.

To gain more insight into the new tool an interview with the project leader on developing the new tool in the Central Denmark Region was also considered necessary. The project is placed at their Centre for Sustainable Hospitals which is owned by the Central Region of Denmark but is an independent organisation that seeks to *"be able to collect and spread knowledge on sustainable transition in the healthcare system and to generate new knowledge through research, development projects and networks"* (Region Midtjylland, n.d.).

As the interviews were conducted in the initial phase of the research it also influenced how much knowledge it was possible to gain on the new TCO-tool as it is launched at the beginning of 2023. It was therefore also decided to follow up with the Danish EPA on the TCO-tool in November to gain new insights. The respondent from the Danish EPA was contacted by email where it was agreed that some new documents on the tool could be sent. This includes a slide-show presentation of both the screening tool and the connecting TCO-tool as well as a PDF on the connecting TCO-tool. These documents are therefore also included as literature for the analysis of the TCO-tools in theory (chapter 4).

Interviews for understanding the TCO-tools in practice

To answer sub-question 2 and understand the use of TCO-tools in practice, interviews with the Danish regions were conducted. All five regions were contacted, but only four out of five regions responded as also visualised in table 3.1.

To understand the use of TCO-tools in practice and the related barriers and drivers it was determined essentially that the respondent was either a tender consultant or a sustainability consultant placed within the procurement department to understand the use of the tools in relation to the procurement process. Notable, for the Northern Region of Denmark, it was possible to have both a tender consultant and a sustainability consultant with insights into the procurement department within the same interview.

As previous mentioned, prior to the interviews, an interview guide was composed to guide the interviews, which can be found in appendix A. The guide was sent to the respondents which allowed the respondents to prepare for the themes of the interviews. For the interviews with the Northern Region of Denmark, Southern Region of Denmark, and Region Zealand it was the same interview guide that was used. For the Central Denmark Region a different interview guide was used. The reason for this is that the Central Denmark Region collaborates with the Danish EPA to develop the new TCO-tool for hospital textiles. Therefore, the purpose of the interviews with the Central Denmark Region was not only to understand the drivers and barriers for adopting the current TCO-tools for CPP but also to understand how the new tool influences adopting new TCO-tools for CPP.

Coding the interviews with the Danish regions

In order to fully understand the barriers and drivers that emerge in practice it is chosen to code the interviews. The interviews have in advance been manually transcribed to enable the coding.

The abductive approach in this thesis is reflected in the coding, as the analysis of the barriers and drivers is based upon both an open (inductive) and closed (deductive) coding (Brinkmann & Tanggaard, 2015). At first, all the transcriptions have been read and initially coded based on points and paragraphs relevant to answering sub-question 2. This open coding includes codes generated from recurring themes of the empirical data.

Afterwards, a conceptual and a more closed coding has been conducted. This second coding is based upon the analytic framework developed by Jesus & Mendonça (2017). The analytical framework derives from a study on barriers and drivers for the transition to a circular economy. It consists of the following factors:

	Factors	Barriers	Drivers
Hard factors	Technical	Technology that are not fitted, a delay between design and adoption, lack of technical support, inadequate training	The development of sharing solutions with greater user experience and convenience, the availability of technology that assist resource optimization, re-manufacturing and regeneration of by-products as input to other processes.
	Economic/ financial/ Market	High initial expenses and capital need, high transaction costs, and uncertain return and profit	Related to the incentives, from the demand side it can relate to resource depletion causing a lack of resources, where on the supply side it can relate to decreasing costs and security of supply
Soft factors	Institutional/ Regulatory	Policies, regulation and standards that hinder the shift e.g. Misaligned incentives	Policies, regulation and standards that support the shift e.g. environmental and circular policies
	Social/ Cultural	Rigidity of business routines and consumer behaviour	Social awareness, shifting the preferences of the consumer

Table 3.2 An overview and description of the conceptually driven codes. Own illustration adopted by (Jesus & Mendonça, 2017).

The factors from this table will therefore be used for answering sub-question 2.

3.3.3 Literature-review

From the initial analysis (chapter 1) it was concluded that public procurement (PP) could play a central role in the transition to a circular economy (CE). The integration of CE in PP is, however, at an emerging stage. To understand why this is the case and what could enable the integration of CE, a literature review on CPP was conducted.

The initial search was done on peer-reviewed articles through the database Scopus. Searching on "circular public procurement" gave 57 articles. The abstract of these was read and here articles for example not focusing on the public organisation or not including a focus on barriers and drivers for the

implementation of CE in public procurement were discarded. The last 18 articles were then briefly read through and here 7 articles (outlined in fig. 3.1) were found to be relevant for understanding the barriers and enablers of integrating CE in public procurement.

However, to fully understand CPP in practice and which approaches could be applied it was also deemed relevant to include grey literature. This, as grey literature often is designed for practitioners compared to the academic literature. For this research there is used grey literature from four sources (see fig. 3.1).

The grey literature was found using a combination of both snowballing and google search. Snowballing from the peer-reviewed articles led to several grey literature. For example, the grey literature (Europaen Commission (2017)) and (Jones et al. (2017)) are referred to by peer-reviewed article Kristensen et al. (2021). In addition, the grey literature Europaen Parliament (2017) is referred to by peer-reviewed Sönnichsen & Clement (2020). The two grey literature by Europaen Commission (2017) and Jones et al. (2017) was also visible when doing the google search.

Searching for the grey literature the keyword "circular public procurement in practice" was used. In order to exclude the search from general grey literature of CPP, is was relevant to include "in practice" in the keyword, as it otherwise gave too many results irrelevant for the research.

As the google search was done both in Danish and in English, it was also relevant to include the danish grey literature (Forum for bæredygtige indkøb (2017)) in the research.

The grey literature by Europaen Commission (2017) is used for the analytical framework for answering sub-question 1, as explained in the following section.

3.4 Analytical framework for answering sub-question 1

From the initial analysis (chapter 1), it could be concluded that CPP in its core is the integration of CE strategies into PP. Moreover, as presented in section 1.2.1, the EU guidance on CPP from 2017 states that the purchasing should be done in such a way that it prioritises the highest level of circularity (ibid.). It is therefore chosen to analyse the TCO-tools in relation to the R-framework presented in fig. 1.1 to understand how the tools support CPP in theory.

As highlighted in section 1.3 it is stated that the Danish Environmental Protection Agency (EPA) is seeking to further develop the TCO-tools. It was in the initial part

of this study discovered through a webinar on the TCO-tools and an interview with the Danish EPA (further explained in section 3.3.1 and section 3.3.2) that the Danish EPA currently is developing a new type of TCO-tool in collaboration with the Central Region of Denmark to be launched at the beginning of 2023. To fully exploit and answer the research question it is therefore deemed necessary to not only focus on the analysis of the existing TCO-tools but also reflect on the current development of the tools to understand the potential.

The currently available tools by the Danish EPA are built from the same structure and ideas whereas the newest tool developed in collaboration with the Centre for Sustainable Hospitals is built upon a new approach. This new tool is divided into two connecting tools: a screening tool and a TCO-tool, where the latter is similar to the existing tools.

To include the different aspects of the tools and how they support the R-strategies, the first analysis (chapter 4) is conducted in three sub-analyses. The first sub-analysis is an analysis of the existing TCO-tools. The second sub-analysis is an analysis of the screening tool for hospital textiles made in collaboration with Centre for Sustainable Hospitals. The third sub-analysis is an analysis that addresses the newest TCO-tool for textiles. The results are hereafter summed up in the last section of the analysis. Through the interview with the Danish EPA and knowledge gained through the webinar, it became clear that the tools can support the user in different ways as well as largely depending on how the tools are utilised. As also highlighted in section 1.3 it includes both that it can be used in different stages of the procurement process as well as despite the tools having some predefined cells the design is flexible. These elements might influence how the tools support the different R-strategies. The analysis, therefore, includes evaluation criteria ensuring that the above is outlined in the analysis to understand the potential of the tools. The criteria are presented in table 3.3 together with a description.

Evaluation criteria	Description
Directly supported	This criterion is based upon whether or not the tools in themselves support the R-strategy independent from the user. This criterion is fulfilled if the tool in itself supports the R-strategy entailing that by just filling out the tool the strategy is supported
Not supported	This criterion is fulfilled if the tool can not include the criteria without some adjustments to the tool. This includes that the user will have to define and create new cells themselves or in general, need a new set-up to be able to support the R-strategy
Indirectly supported	This criterion is fulfilled if the tool can support the R-strategy without any adjustments in the tool, such as adding a cell, but supports the R-strategy depending on how the user uses the tool

Table 3.3 An overview of the different criteria for analysing the TCO-tools and how they support the R-strategies

Circular strategies supported by the TCO-tools 4

The purpose of the following analysis is to understand which circular strategies are supported by the TCO-tools and how. The circular strategies are those presented in fig. 1.1; Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover. It is in the text for each of the strategies highlighted how the tools are supporting the strategies based upon the evaluation criteria presented in section 3.4. To give a better overview of which R-strategies are supported and how they are supported, the evaluation criteria are included in a bracket in the text together with the strategy as well as included in an overview in the sub-conclusion of this chapter. As presented in the fig. 3.1 the analysis is based upon the interviews with the Danish EPA and Centre for Sustainable Hospitals as well as the knowledge gained by participating in the webinar on TCO-tools. This also includes documents and presentations gained and collected through the interviews and webinar as well as downloading and analysing the available TCO-tools found on the Danish website "Den ansvarlige indkøber".

4.1 Sub-analysis 1: Existing TCO-tools

4.1.1 Description of the tools

The existing tools are as described in section 1.3 a spreadsheet. In general, they consist of five coloured areas for different calculations and data which all include text boxes describing how and what should be written in the different cells as illustrated on fig. 4.1

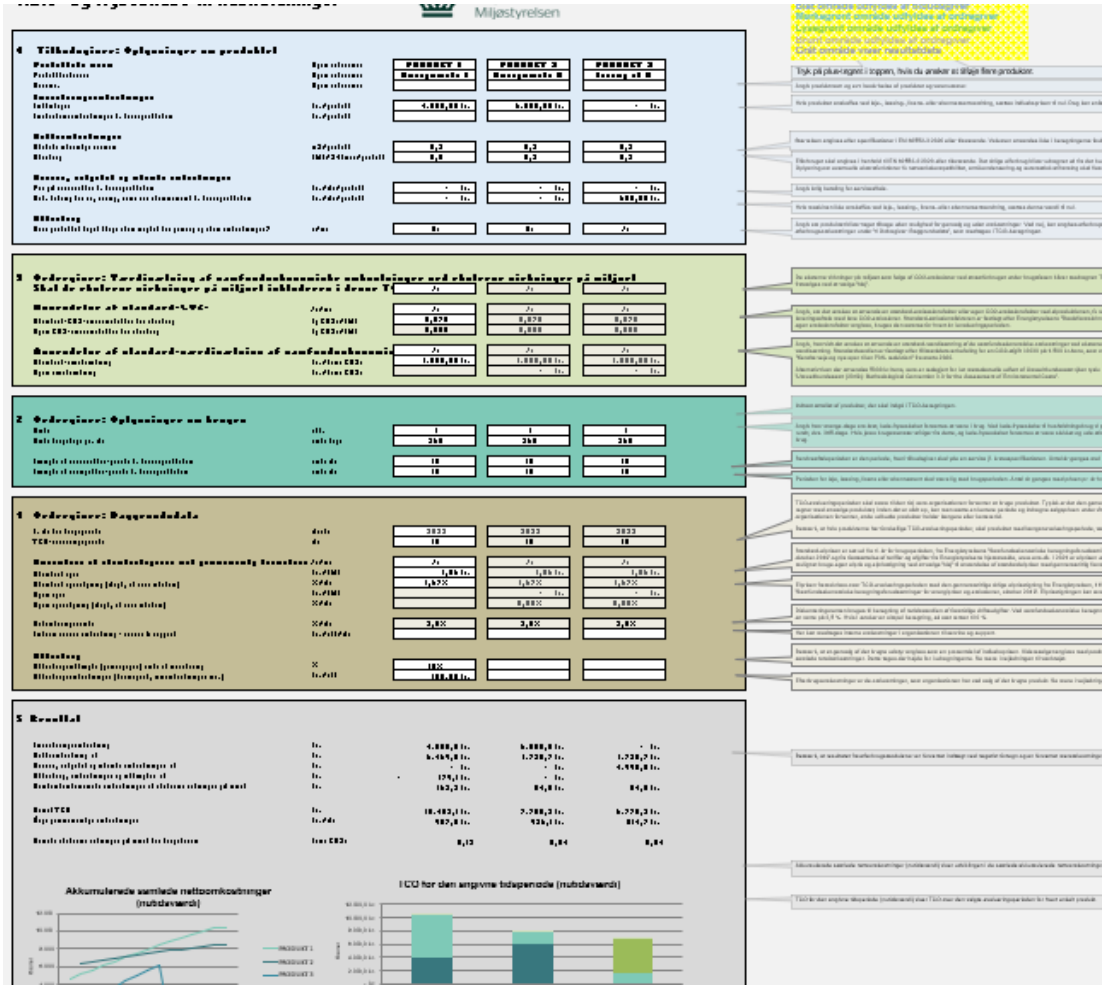


Figure 4.1 A screenshot from the existing TCO-tools, outlining the structure of the tool.

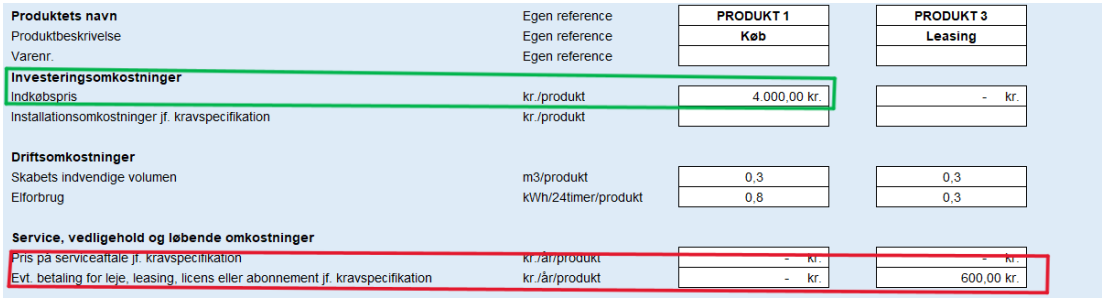
- The first coloured area (light blue) covers the collected data from the suppliers such as the price for the product, some technical specification on the product e.g. the energy use, water use or other data needed for further calculation of operational costs, costs related to services and installation fees as well as if the product is returned to the supplier. In addition, the tool (not visualised on the fig. 4.1) provides a data-collecting list for this area, so the purchaser knows what to ask the suppliers for. The list should be adjusted in the case of exclusion of some costs such as cost for leasing or service if these are not an option in the tender.
- The second area (light green) is the data cells for the socio-economic cost of environmental externalities. Here the tools provide some standard-emissions factors for different relevant resource usage such as fuel, water, and energy as well as a standard socio-economic cost factor based upon well-known and acknowledged sources. It is however also an option to include own or other standards, which could be relevant if an organisation has some special agreements e.g. a power purchase agreement with low emissions.

- The third area (dark green) is related to the need and function of the product which can include how many products are asked for or for some products it can be relevant to understand the number of days pr. year it is in use or in case of leasing or renting as well as service agreements the period for this should be included.
- The fourth area (brown) covers some background data for the calculations, which include data such as the evaluation period for the TCO or the use pattern for some of the products such as computers, which can be filled out by using some standard measures included in the tool. Moreover, the price of energy, water, etc. can also be included based upon standards or own data. The area also covers if there are any either positive or negative costs in relation to end-of-life as this can include an earning from if the product is resold and any costs in relation to removal and transportation.
- The fifth and last area (grey) are the results of the TCO visualised both as a price as well graphically. The calculations are based upon the equations shown in section 1.3, where it is possible to see the both yearly average price through the period, the amount of CO2e for the different products as well as the accumulated price including all the costs.

4.1.2 Analysis of how the tools support the R-strategies

Refuse (Not supported): The existing tools are product-specific tools used to compare the same product, implying that it already has been determined that a certain product/service is required to fulfill the function. It is therefore considered that the tools can not support *refuse*, as refuse is more related to either how the need can be fulfilled by something else than by the product or by a radically new product.

Rethink (Indirectly supported): The tools allow for a comparison of different aspects of ownership including sharing the product through leasing or renting. Visualised on fig. 4.2 the user can without extending the tool type include the yearly costs for renting or leasing the product (marked with red) as well as the purchasing price in the case of buying the product (marked with green).



Produktets navn	Egen reference	PRODUKT 1	PRODUKT 3
Produktbeskrivelse	Egen reference	Køb	Leasing
Varenr.	Egen reference		
Investeringsomkostninger			
Indkøbspris	kr./produkt	4.000,00 kr.	- kr.
Installationsomkostninger jf. kravspecifikation	kr./produkt		
Driftsomkostninger			
Skabets indvendige volumen	m3/produkt	0,3	0,3
Elforbrug	kWh/24timer/produkt	0,8	0,3
Service, vedligehold og løbende omkostninger			
Pris på serviceaftale jf. kravspecifikation	kr./år/produkt	- kr.	- kr.
Evt. betaling for leje, leasing, licens eller abonnement jf. kravspecifikation	kr./år/produkt	- kr.	600,00 kr.

Figure 4.2 A screenshot from the existing TCO-tools. The green area marks where the purchase price should be typed in and the red area marks where the costs related to leasing or renting the product should be included.

Utilising the tool allows for understanding whether or not a product-service model could be an option from a cost perspective in the preparation phase and thereby understanding what ownership type to ask for in the tender. However, it can be concluded that the tool only indirectly supports *rethink* as despite the tool does have a cell including the possibility of leasing or sharing a product, it still depends on the user to conduct the additional analysis in the preparation phase. To support the R-strategy the user should first seek to understand together with the end-users whether a product-service system can fulfill the needs as well as go in dialogue with potential suppliers to understand whether it can be supplied. The calculation only includes some limited socio-economic costs for the impacts on the environment in the use phase implying that it is only the product from the potential supplier that is assessed and not the business model itself. It is therefore not possible to evaluate whether or not a product-service model is more favorable from an environmental point of view.

It should also be noted that the tool can only assess and compare products with the same use-phase pattern resulting in the tool not being suitable for e.g. assessing multi-functional products with non-multi-functional products. Such an approach to rethinking the product would require a more systemic and innovative approach as well as other additional calculating than the existing tools can provide. Moreover, the more internal assessment and dialogue with the end-users on whether an internal sharing of the products lowering the number of products needed is also something that will have to be dealt with alongside the tool.

Reduce (Directly supported): The tools include the possibility of calculating both the direct cost of resources used during the lifetime of the product as well as the socio-economical cost related to the resource use and thereby also a potential reduction in these. *Lifetime* is here defined as the time of ownership which covers the time from purchasing/leasing or renting of the product to the end-of-life of the

initial function which can be either that the product is returned, reused, recycled, or in other ways disposed. As a result, it is possible to compare the different products based on some measurable resource use in the use-phase such as energy, water, or fuel, and how it influences the total cost. It can be concluded that the tool directly supports *reduce* as the calculation by just completing the tool will include a perspective on reduce. This is the total costs and material/resources can be seen as dependent variables implying that a more resource-efficient product also reduces the socio-economic costs and thereby also the total cost. To illustrate this is an example shown below.

The example shown below is for a buy of servers and the data included is fictive data. It can be useful both in the preparation phase and for the actual tender. If used in the tender; the findings can be used to evaluate which supplier has the lowest TCO. If used in the preparation phase; the tool can be used to establish technical requirements as well as award criteria to be included in the tender based on the knowledge gathered on which factors can support low resource use and thereby also a low TCO. For example, two different models have been included; An expensive model with an electricity consumption of 200 watts and a cheap model with an electricity consumption of 320. The expensive model has a purchasing price of 30.000 DKK and the cheap model has a purchasing price of 20.000 DKK. These are the only two differences made. The use period is set to 6 years and for the additional data is the standard data provided in the spreadsheet used or set to zero (e.g. there is not included any service agreements or installation fees)

The results are:

Model	Expensive model	Cheap model
Investment costs (DKK)	30.000	20.000
Operational costs (DKK)	26.354	42.166
Socio-economic costs (DKK)	1.102	1.763
Total costs (DKK)	57.456	63.929
External impacts on the environment from the usephase (tons CO2e)	0,82	1,31

From the results, it can be concluded that energy efficiency has an influence on the environmental impacts and the total cost. The expensive model is cheaper in the long run while also having a lower impact on the environment. Used in the preparation phase, the user would become aware that electricity consumption has

a high influence and could use this to set the award criteria, implying that it would be weighted positively to provide a more energy-efficiency product. Moreover, the supplier providing a more energy-efficiency server will also have a lower total cost, implying that if TCO is used as a parameter in the tender compared to just for example lowest price, it would allow for that supplier to be chosen. For this example, electricity consumption was used, but it can be used in a similar way for other parameters. The tools include some different parameters that are useful for the specific product.

Important to notice is also that the tool does not cover a potential burden shift as the impacts from the production and end-of-life are not included. Entailing that a supplier might be able to deliver a more resource-efficient product than others which results in a lower environmental impact in the use phase. However, it is not possible to assess by the tools whether the adjustments to the design can have increased the resource use and environmental impacts from the production and extraction of the materials.

Reuse, Refurbish, Remanufacture, Repurpose, Recycle (Indirectly supported): The tool does provide a cell for including costs related to any earnings by reselling the product (given a percentage of the purchasing price). Moreover, a yes/no cell for take-back systems if the supplier takes back the product. Here "yes" entails that the suppliers takes-back the product with no possibility of earnings and no additional costs. It does however depend on the user to investigate whether or not resale is an option as well as seek to ensure that the product is either reused, refurbished, remanufactured, repurposed, or recycled. This also includes that the user themselves will have to find the different options and the related costs. It is therefore concluded that the tool only indirectly supports *Reuse, Refurbish, Remanufacture, Repurpose* and *Recycle*. The different R-strategies could also be viewed as other than end-of-life options for the organisation, including that either, etc. a reused or remanufactured product is bought or that a product includes recycled materials. The user will have to find the different options on the market themselves, but if such a product either increases or decreases the lifetime of the product compared to, etc. buying a new product or if the resource efficiency of the product is affected it could be supported by the tools. For example, the user could assess buying a reused product compared to buying a new product where the lifetime of the reused product is set to 3 years and the new product is set to 6 years. It is assumed that a reused product is cheaper in purchasing price than a new product. The difference in lifetimes can be included in the tool by either setting a

resale price for the new product, entailing it is sold after the 3 years or the number of reused products could be adjusted to a use period of 6 years. It should be noted that in general, the existence of standards on the calculation of the lifetimes of different products is very limited. Across the different existing TCO-tools, a standard only exists for light bulbs, entailing that it is possible to compare how many bulbs are needed from the different suppliers to fulfill the need during the chosen evaluation period. It should however also be noticed that the tool only reflects the cost and resource use in the use-phase implying that it is not possible to address the environmental impacts of etc. buying a reused or new product.

Repair (Indirectly supported): The tool does provide a cell for service agreements etc. entailing that it is possible for the user to include additional costs related to repair and maintenance of the product. These additional costs will be included in the total costs which could influence higher total costs compared to suppliers that do not provide this. However, if the lifetime of the product could be increased by repairing the products this could be included similar to the above example with reused vs. new product. It would therefore be based upon this calculation that the user could be reviewing whether or not repair could be beneficial from a cost perspective. It can be concluded that it only supports *Repair* indirectly, as it highly depends on how the user is utilising the tool. Extending the lifetime as well as including the impacts of the spare part can however not be assessed from an environmental perspective entailing, that it would be up to the supplier themselves to understand this in another way. However, the cost perspective could reflect whether or not the product is designed to be repaired easily. This is the case as it would probably entail less resources and less cost compared to a product that is difficult to repair.

Recover (Indirectly supported): Similar to reuse, recycle, etc. the costs related to end-of-life can be included in the calculation. For recover this would probably entail a negative cost, implying that suppliers who can provide a product with either a longer lifetime than needed in the organisation or a product that would allow for either one of the above options, could be awarded. It can therefore be concluded that the tool indirectly supports *recover*.

4.2 Sub-analysis 2: Screening tool

4.2.1 Description of the tool

The screening tool is based on Central Region of Denmark's own desire to decrease their waste by replacing single-use with multiple-use textiles when it makes sense both from an environmental and an economical point of view. Moreover, it is partly financed through the EU LIFE IP-project, Circular Economy Beyond Waste, which is a program supporting the implementation of the EU's Circular Economy Action Plan (CEAP) as a part of the European Green Deal (Centre for Sustainable Hospital, Project leader, 2022).

In general, by using the screening tool it can be determined whether a tender should be designed upon asking for a single-use or multiple-use textile type. If then a multiple-use textile product does make sense, it can also be used to understand which parameters that influence both the costs and environmental impacts of the product. The next step is then to determine which supplier to choose which also includes utilising the connected TCO-tool. However, this part will be covered in the third sub-analysis. The tool is designed to be a screening tool as highlighted in section 1.3 since a lack of standards and the EU Directive on Public Procurement currently hinder the inclusion of several environmental impacts in the TCO-tools. The Danish EPA and Central Region of Denmark have tried to circumvent this barrier by doing the comparison of single-use and multiple-use prior to the tenders process and thereby including a perspective on the life-cycle of the products beyond the use-phase. This might also have an effect on how the R-strategies are supported which will be analysed in the following. To include environmental impacts the tool is connected to the Life-cycle inventory (LCI) database; Ecoinvent. To access the tool the user will have to get a login from the Danish EPA to ensure the data is kept protected as the data requires a license, which also includes that the background data is not available for the user (The Danish EPA, Officer, 2022).

The screening tool is similar to the existing tools since it is also an excel-spreadsheet. It consists of different levels as well as several sheets. The first sheet is an introduction to the tool, where the next is both where the product is chosen and the need is determined, as well as the first level of the tool. It is a quick screening based on archetypes from data collected at the Central Region of Denmark and their laundry service central. The first version of the tool that is to be released at the beginning of 2023 will include four archetypes relevant to operations rooms

(surgical gown, surgical covers, surgical blankets, and thermal jackets). The quick-screening is visualised on fig. 4.3 and includes the environmental impacts all the way from cultivation and extraction to production of the raw materials to the use-phase, as well as the economical costs from either buying or leasing the product. Furthermore, the costs related to washing and drying the textile. The user will have to define the need as well as fill out the information on whether the product is owned by themselves or not and the specifications related to their laundry service.

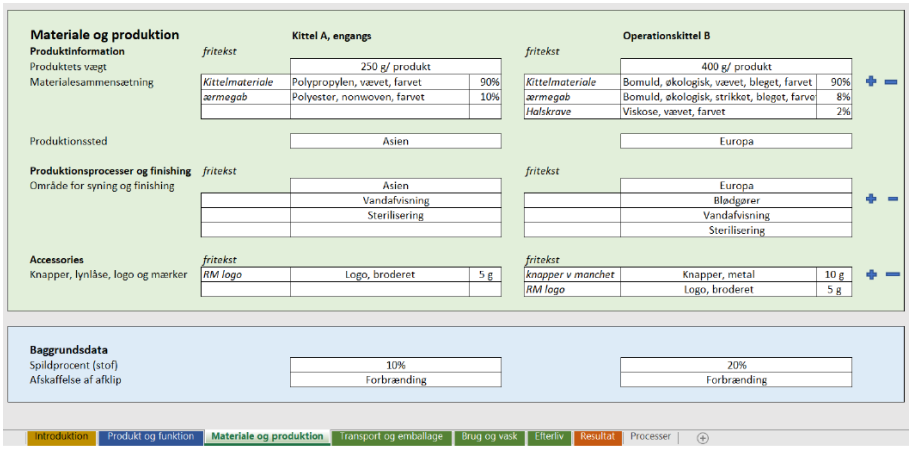


Figure 4.3 A screenshot from the coming screening tool, illustrating the initial screening based upon archetypes from the Central Region Denmark. Showing an example of a potential tender on surgical gowns. Source: (CDR & Danish EPA, 2022).

The user can also do a more in-depth analysis based upon on-shelf single-use and multiple-use products already delivered on the market (Centre for Sustainable Hospital, Project leader, 2022). This level of screening includes among others, more information on the effect of different materials, end-of-life, transportation in relation to the delivery of the product, logistics in relation to laundry service and inventory, as well as information from the laundry service. These sheets can be found in appendix B.

It is not possible to show how the results of the screening are going to be visualised as well as which specific parameters it is going to include as at the time of the composition of this thesis it was not yet fully determined. It is however indicated that it is going to include a comparison of single-use and multiple-use based upon the impact categories; climate change, water usage, climate change fossil, acidification, ecotoxicity, freshwater, resource use, fossils, minerals, and metals. Furthermore, along with the comparison, it is also going to include the impacts of different life-cycle phases for each of the textile types. The total cost related to the product is also going to be visualised (CDR & Danish EPA, 2022). It

should also be noted that the tools currently do not include chemicals such as Per- and polyfluoralkyl subtances (PFAS) which are used to impregnate multiple-use textiles as no alternative exists. It comes off during the washing of the textile, however, this is not possible to include in the tool currently, do to a lack of standards.

4.2.2 Analysis of how the tool supports the R-strategies

Refuse (Directly supported): The purpose of the tool is to determine whether or not it makes sense to design the tender for a multiple-use or single-use product, entailing that the user is seeking to *Refuse* to buy single-use when it makes sense. Moreover, multiple-use can be viewed as a radically different product than single-use. It is therefore concluded that the tool directly supports *refuse* as just by utilising the tool the user is seeking to replace the product when it makes sense. Furthermore, it is not dependent upon the user, as the tool provides the comparison as an integrated assessment. The user is both provided with an alternative product as well as the assessment on whether or not it makes sense. The tool is linked to the system of the organisation, entailing that the tool includes the end-users, workflows etc. linked to circulating the textile. This includes that it does not focus only on the product that needs to be purchased but more on the function it needs to fulfill. However, as visualised on the information needed to conduct the assessment it would require that the user collects the required data, implying that the user will have to go in dialogue with the end-users as well as their laundry service to understand if a shift to multiple-use is possible.

Rethink (Indirectly supported): Similar to the existing tools the screening tool does provide cells for including whether or not the product is owned by themselves. Utilising the tool it is possible to assess the difference in the economical costs of either including a purchasing price or a service agreement if doing the analysis twice. This implies that first the user needs to do the assessment of buying the product and then an assessment of leasing and compare these two assessments. It can therefore be concluded that the tool indirectly supports *rethink* as the user themselves have to do the additional assessment. A shift in ownership including ou-tsourcing the laundry service might also influence the logistics and thereby influence whether or not multiple-use makes sense.

Reduce (Directly supported): Compared to the existing tool the screening tool does not only include some specific environmental impacts from the use-phase

but the impacts from the entire life cycle. This among others include that the user can utilise the tool to understand the environmental impacts of different materials, as well as what might influence the resources for transportation and production. As an example, changing the area of production from Europe to Asia or the other way around for multiple-use textiles could influence whether or not multiple-use still makes sense. Production in Europe would probably reduce the environmental impacts as the background data is based on different electricity mixes. The electricity mix in Europe would be based on greener and more renewable energy sources compared to production in Asia. Different from the existing tools the screening tool is not focused on reducing the total cost of the product but more on showing when it makes sense to move to multiple-use. This includes that the user themselves more actively have to utilise the tool for analysing what might influence a reduction in resource use. It can however still be concluded that similar to the existing tool *reduce* is supported directly by the tool, as the tool by the results shows whether or not a reduction in resources occurs when moving from single-use to multiple-use.

Reuse, recycle, recover (Directly supported): It is not visualised on fig. 4.4, however, end-of-life for both packaging and the different textile parts includes a drop-down menu, where reuse, recycle, incineration, and landfill can be chosen.

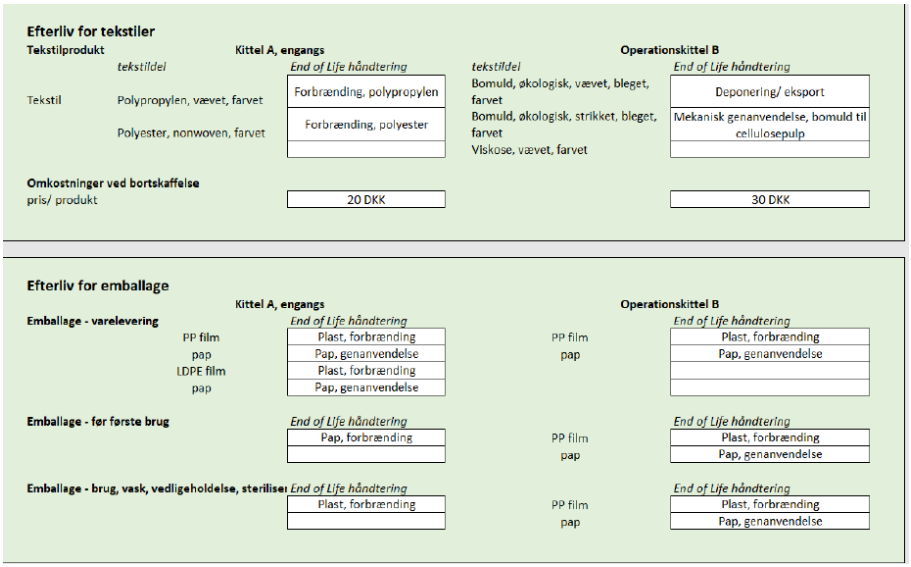


Figure 4.4 A screenshot from the coming screening tool, illustrating the end-of-life for both textiles and packaging. Source: (CDR & Danish EPA, 2022).

Incineration is here viewed as *recover*, as the environmental background data from Ecoinvent includes that it generates electricity and thermal energy (Ecoinvent, n.d; The Danish EPA, Officer, 2022). Compared to the existing tool the user will

not have to investigate different options for end-of-life as these are provided by the tool. This includes that the tool in itself without depending on the user includes an assessment of the effects of the different options. It can therefore be concluded that the tool directly supports *Reuse*, *Recycle*, and *Recover*. The user could however furthermore utilise the tool to understand how they compare differently. Here the user will have to run the assessment twice, first with for example *reuse* and then with for example *recycle* and then compare the results. This kind of assessment and information can be used for the market dialogue as well as for setting award criteria. The tool will both provide the difference in costs as well as the differences in the environmental impacts of the options in the results.

Repair (Indirectly supported): The tool does provide a cell for costs related to service agreements, which can include that the product is repaired. The service agreement is linked to the laundry service in the tool entailing that it would only be based upon the costs that the tool could provide inclusion of *repair*. Moreover, if such an agreement would influence the expected lifetime of the product, this could influence how many multiple-use products are needed. With such an adjustment it might influence if multiple-use makes sense or not. However, this would entail that the user themselves seeks to understand the influence thus it can be concluded that *repair* is only indirectly supported.

Refurbish, Remanufacture, Repurpose (not supported): The tool provides a drop-down menu for end-of-life, this does not include *refurbish, remanufacture or repurpose* entailing that the user will have to adjust the tool themselves to include it. It is therefore concluded that the tool does not support *refurbish*, *remanufacture*, or *repurpose*. It is, however, stated in the interviews both by Centre for Sustainable Hospital, Project leader (2022) and The Danish EPA, Officer (2022), that the current tool is a first version which also includes that it reflects the current market, implying that these three options are not available and widespread. This might change over time which is also why the tool has been designed in such a way, that it can be included in the future.

4.3 Sub-analysis 3: TCO-tool for hospital textiles

4.3.1 Description of the tool

The last tool is the TCO-tool for hospital textiles. In general, the tool is built similarly to the existing tools in the form of an Excel spread-sheet divided into

the same five coloured areas. It is product-specific and can only be utilised for different types of multiple-use textiles. It can be used alone or in connection with the screening tool. However, only a few of the parameters assessed by the screening can currently be included in the tool as not all of the environmental impacts can be verified which is also reflected in the analysis below. The result of the screening process should therefore be seen as a list of which parameters could make sense as either technical or award criteria. Compared to the existing tools the lifetime of the product plays a major role in the tool, implying that different products are compared on their quality. The calculation in the tool differs a bit from the existing tools as the resource use is based upon pr. kilograms of textile and not the amount as this can be verified in relation to the laundry service.

At first, the user will have to define the evaluation period for the calculation, as well the cost related to the laundry service including the costs related to washing, drying, impregnation etc. and transportation costs back and forth to the hospital. Furthermore, electricity use, water use, etc. pr. kilogram textile from the laundry service is also to be collected. Similar to the existing tools the tool includes some standards that can be used for this. The next steps are special for the TCO-tool on textiles as here the user will have to collect data to calculate the lifetime of the product based on the performance of the textile. The standards are based on the European Product Environmental Footprint Category Rules for apparel and footwear. It includes that information from the supplier on the specification of the textile is weighted against some standards reflecting the lifetime of the product. Visualised on fig. 4.5 the supplier will have to provide some specific criteria for their textile.

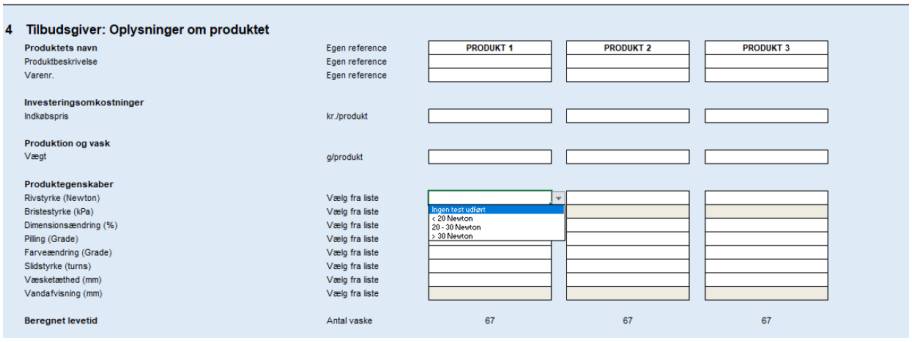


Figure 4.5 A screenshot from the coming TCO-tool for hospital textiles, illustrating the list of information (depending on the type of textile) that should form gathered from the supplier. Source: (Danish EPA, 2022).

The list of criteria for textiles illustrated on fig. 4.5 should not be completed by the supplier but should be filled out in relation to the specific textile type. The list of textile types is given in the tool together with the tables for calculating the

lifetime. As visualised on fig. 4.5 there are three options to choose between, they all represent points that can be found in the additional tables. The points are given in relation to the performance of the product thus the higher the sum of points in total from each of the criteria, the longer lifetime. This calculated lifetime determines how many products within the given use period should be acquired to fulfill the need. The weight of the product together with the number of products needed influences the costs related to the laundry service, both in terms of the socio-economic costs related to emissions from the resource use (electricity use, water usage, etc. pr. kilogram textile) as well as additional costs for the service.

4.3.2 Analysis of how the tool supports the R-strategies

Refuse (Not supported): The tool similar to the existing tools only covers one type of product, here multiple-use textiles. This implies that when using the tool it has already been chosen to design the tender for a specific product. It is therefore concluded that the tool does not support *refuse*. However, used in connection with the screening tool it can be viewed that by just utilising the tool a new and more radically product is chosen compared to single-use.

Rethink (not supported): The tool is only designed to include that the multiple-use textile is bought by the organisation and not for example rented through laundry services. Visualised on fig. 4.5 there is not a cell included for leasing, renting, etc. as with the existing tools. It is up to the purchaser themselves to re-design the TCO-tool for their own systems if they choose to rent or lease compared to buying the product. It can therefore be concluded that the tool does not support *rethink*.

Reduce (Directly supported): Similar to the existing tools *reduce* is directly supported as the tool includes the socio-economic costs related to the resource use. However, specific for this tool is also that the number of products is included. A lower number of products needed would reduce the number of resources needed, both in terms of materials for the textile as well as the resource in the use-phase related to the laundry service. It should however be noted that as the resource use related to the laundry service is based upon weight, the use of resources in the use-phase is not only influenced by the number of products but also the material. However, similar to the existing tools, the tool does not assess whether or not a burden shift is caused as one supplier might deliver a good quality product that uses fewer resources in the use-phase, but has a high use of resources in the

production-phase.

Reuse, refurbish, remanufacture, repurpose, recycle, recover (not supported): The tool does not include a resale price or any cost related to when the product has fulfilled the need at the organisation at end-of-life. It can therefore be concluded that the tool does not support *reuse, refurbish, remanufacture, repurpose, recycle and recover*. It is up to users themselves to figure out the influence together with potential suppliers in the preparation phase what an option could be. *Reuse, recycle, and recover* could be supported by using the screening tool which would help set the award criterion based upon the most preferable in relation to the product type and textile. Moreover, the current standards and list of textile types do not reflect on whether they consist of for example recycled materials, entailing that it only depends on the quality of the textile.

Repair (not supported): The tool does not provide any cells or standards to include costs related to the repair of the textiles which could extend the lifetime of the product. The rationale behind this is that the tool covers different textile types implying that some textile types could easier be repaired than others and as there currently do not exist any standards the data can not be verified (Danish EPA, 2022). It can therefore be concluded that the tool does not support *repair*.

4.4 Sub-conclusion

In general, it can be concluded that despite the tools being able to compare different business models and end-of-life options it still largely depends on the user as only a few of the R-strategies are directly supported. Moving from the existing tools to the screening and connected TCO-tool also includes a shift in the resource hierarchy as illustrated on table 4.1. Using a screening tool, in general, allows to include a more in-depth analysis of two different systems, which here also includes that the tool can support *refuse*. Compared to the existing tools the purpose of the screening tool is to understand the function that needs to provided. The tool therefore also includes the system of the organisation including workflows etc. Visualised in table 4.1 the screening tool also depends less on the user to support the different strategies as several of the strategies are directly supported. However, as it is a screening tool and only used prior to the tender process it should be noted that it still depends on the user seeking to include the different parameters in the tender, but the tool in itself supports the strategies.

The existing tools depend largely on the user and the utilisation of these, however, it can be viewed that they support several of the strategies compared to the two tools for hospital textiles. Despite the TCO-tool for textile being developed similarly to the existing tools, it is limited in supporting the strategies as the market and standards for textile is just not there yet (Centre for Sustainable Hospital, Project leader, 2022). The current market situation is not reflected in the existing tools as they are all built upon the same model, which can explain the difference, however, the tools can be designed for it.

All of the tools support *reduce* directly which includes that by just filling out the tool it will provide a calculation of different products and show which products are more resource efficient than others. A more resource-efficient product will reduce the emissions related to the use-phase implying that fewer resources are needed. Moreover, these emissions are reflected in the total cost by being multiplied by a socio-economic cost factor.

	Existing tools	Screening tool	TCO for textiles
Refuse	-	+	-
Rethink	(+)	(+)	-
Reduce	+	+	+
Reuse	(+)	+	-
Repair	(+)	-	-
Refurbish	(+)	-	-
Remanufacturing	(+)	-	-
Repurpose	(+)	-	-
Recycle	(+)	+	-
Recover	(+)	+	-

Table 4.1 An overview of the R-strategies covered by the TCO-tools. [-] if the tool does not support the strategy, [(+)] if the tool indirectly supports the strategy, [+] if the tool directly supports the strategy

Barriers and drivers for adopting TCO-tools in practice 5

The purpose of this chapter is to present the barriers and drivers for adopting the TCO-tools in practice. It is based on interviews with the four Danish Regions and coding of these. The more conceptual-driven codes developed by Jesus & Mendonça (2017) and presented in table 5.1 guide the overall analysis, where the sub-codes that emerged from the initial coding are presented and categorised based on these. The sections are therefore headed according to each conceptual-driven code.

5.1 Technical barriers and drivers

Using the tools in the healthcare sector appears to increase the complexity of what they must be capable of calculating and which parameters to include. The complexity of their own systems is viewed as technical barrier. This is especially the case when it comes to moving from single-use to multiple-use;

> We have completely different requirements for materials and chemicals. It is just a much more extensive process and requires in-depth analysis as for example some multiple-use products (red:textiles) can include chemicals to ensure barriers (red: cloth barrier), which is not something we want in the hospitals, so it requires really in-depth work and resources looking into it.
>
> (Region of Northern Denmark, Tender Consultant, 2022)

As highlighted in the quotation should the tools need to be able to calculate several parameters to be able to be applicable for their systems. This applies not just for textiles, but also to other clinical items since they must all meet hygiene and patient care standards (Region of Southern Denmark, Sustainable Procurement Consultant, 2022; Region of Northern Denmark, Tender Consultant, 2022). Furthermore, this also includes that hospital's systems do not always provide the necessary technical specifications;

> I think it would make sense for some products (red: TCO-tools) and then there are others, especially single-use, the switch from single-use to multiple-use is really

> interesting, but it requires a capacity in the Central Sterile Supply department and some available staff to move it down there.
>
> (Region of Southern Denmark, Sustainable Procurement Consultant, 2022)

In order for adopting the tools for products that requires a more system change it is viewed that their systems and its limitations should be reflected in the tool. It is suggested by the respondent from Region Zealand that this could be strengthened by avoiding silo-thinking when developing the tools;

> with such a tool you must beware of sitting in a form of the silo, outside or away from the hospitals, and seek to develop it, but you need to be a part of the inside otherwise it will not be able to function.
>
> (Region Zealand, Tender Consultant, 2022)

If the tools are developed together with or close to the user it can be seen as a technical driver for using the tools as they would result in the organisation do not themselves have to adjust the tools in relation to their systems. This is also highlighted by another respondent who believes that when something can be shared by other Regions it is easier and more accessible to adopt knowledge as it comes from what feels like colleagues (Region of Northern Denmark, Sustainability Consultant, 2022). Such an approach is however not synonymous with adoption as it still highly relies on sufficient training. Lack of competencies on how to use the tools is currently viewed as a technical barrier;

> we cannot make demands for something that we cannot work with ourselves, so if we want to use these TCO-tools and ask the suppliers for it, then we also have to be able to do it ourselves and (...) none of my colleagues or myself are sufficiently practiced at this.
>
> (Region of Northern Denmark, Tender Consultant, 2022)

The tools are not viewed as simple and intuitive but as something that requires that resources are set aside for the training of the employees. This is also the case in the Central Region, as despite the more practical implementation of the new tools is still discussed in the procurement department, it is agreed that an allocation of resources for educating the employees will be necessary (Central Denmark Region, Sustainable Procurement Consultant, 2022).

5.2 Economic, Financial and Market barriers and drivers

In general, it is argued among the respondents that the implementation of TCO-tools in relation to circular procurement highly depends on the product area and

current market conditions. Among other factors, it is not enough that the public organisation might be ready as the calculation also depends on the supplier;

> If we are to make a calculation it requires many different aspects of their products that they suddenly need to be able to account for and sometimes it is the case that they rarely even know the origin of their products.
>
> (Region of Northern Denmark, Sustainability Consultant, 2022)

As highlighted in the quotation there is currently a challenge related to getting the needed information to fill out the tools. It can therefore be argued that one of the main Economic, Financial, and Market barriers barrier for adopting the tools is if the suppliers can not provide the information needed to fill out the tools. The respondent further argues that it also depends on the supplier's willingness to share the data and do the additional effort especially if the data are to be delivered prior to the actual tender process. However, it is suggested by the respondent that this could be strengthened by introducing streamlined requirements and tools. The argumentation is based upon learnings and positive feedback from suppliers in a recent involvement in developing streamlined requirements for packaging in the Nordic countries. Thus, lowering the differences in the requirements increases the willingness of the suppliers. One of the main Economic, Financial, and Market drivers for adopting the tools is that they could increase the willingness of the suppliers by being a streamlined tool used across different organisations. However, this still depends on whether or not they are adopted and used similarly within different organisations. The respondent from the Central Region of Denmark also states that the market conditions and willingness of suppliers are reflected in their general approach to circular procurement and would also influence in which areas it would make sense to apply the tools;

> We (red: sustainability consultants within the procurement department) are not always a part of the tenders, especially when the market is monopolised and very few suppliers exist, then we do not apply any circular or green requirements, as it is more important just to be able to have the product.
>
> (Central Denmark Region, Sustainable Procurement Consultant, 2022)

This, together with the relevance of the existing tools from the Danish EPA within the sector can also be seen as one of the Economic, Financial, and Market barriers to the current uptake of the tools which in general across the Regions is almost none existing. There are a few examples of where the tools have been applied or considered. In general, IT in the Regions is often bought through the public

procurement service SKI, which has increased their focus on introducing and using the TCO-tools for their tenders (Region of Northern Denmark, Tender Consultant, 2022; Region Zealand, Tender Consultant, 2022; Central Denmark Region, Sustainable Procurement Consultant, 2022).

The intention of SKI is questioned by one of the respondents; *"SKI, might seems to do a great job from the outside and say that they work with environment and sustainability, but if you take a look at their tender, then it is economy that is weighted the most"* (Region of Northern Denmark, Tender Consultant, 2022). Applying it from an economical angle is also how the Regions have introduced it in some areas of their procurement;

> when talking medico, it will make good sense (...). What we have done up until now, is that we have simply looked at cases, for example, how many products are needed in a treatment period of 14 days, and then compared. It is an economical approach and not because we necessarily are seeking to reduce the environmental impact there, but because it may well be that two machines are cheaper than one machine, where the environmental impact would be better with one machine.
>
> (Region of Southern Denmark, Sustainable Procurement Consultant, 2022)

Another respondent provides an example of how TCO-tools were used during a tender for refrigerator-freezers. Approximately half or one-third of the models had a purchase price that was twice as high as the others; however, the models were built differently, implying that they were more resource efficient and would have paid for themselves within three years.

> Then all of a sudden you had to use this TCO-tool and it just did not make sense because the price you as a purchaser are assessed on is a "here and now price". It, therefore, became a competition requirement and was weighted positively if you had a technology that was power-saving (...) So, they went with these models, but it is not because they did a TCO calculation, it is because they used common sense and said we can actually do something with this electricity use.
>
> (Region of Northern Denmark, Sustainability Consultant, 2022)

Taking advance of the economical gains from using the tools can both be viewed as an Economic, Financial, and Market driver and a barrier to adopting the tools. Despite the fact that using the TCO-tools would be useful in terms of saving money, the rewards from the savings are gathered too late since the Regions are assessed by how much they can decrease here and now rather than in the future. However, if the tools are able to both showing the economical reductions and environmental

reductions it is viewed as a driver for convincing the top management and getting them on board;

> If it both will reduce the environmental impact or CO2 footprint plus the model also can show that it would reduce the costs, then I think it would be easier to get them convinced (red: top management), but it would still require that the market is ready..
>
> (Region of Southern Denmark, Sustainable Procurement Consultant, 2022)

It is, however, a twofold process as the introduction of the tools in the first place would require that some preconditions are in place in the organisation to be able to show the benefits and remove the uncertainty on whether it can pay off;

> It can be difficult as if you were to use these TCO-tools then you will get some offers and then you will get some prices and you will get something with some power consumption and so on. Maybe also have that socio-economic cost included and it is only then, when you have the offers, that you really can know who has the best TCO price in the long term, that is one thing, but we are required prior to the tender to get the management's OK for us to consider it at all, so we can not come up with that calculation up front, we only know it when we get the offer.
>
> (Region Zealand, Tender Consultant, 2022)

As highlighted in the quotation despite the market might be able to provide more circular products and the tools could show the benefits of these it does not necessarily result in adopting the tools. It can be argued that the top management's perception of the use and purpose of the tools is critical for how and if the tools can be used. It can therefore be seen as an Economic, Financial, and Market barrier to adopting the tools that require information from the market before being able to benefit from it. In addition to these economic factors and the supply side of the market, it was discussed by some of the respondents that they as the demand side, have some incentives for adopting the tools. This is related to the conditions experienced under Covid-19 as well as still occurring due to the war in Ukraine.

Covid-19 resulted in high demand for single-use textiles and with large demand, the requirements for the products were lowered resulting in products with higher environmental impact and bad quality than usual to ensure a supply. Moreover, the war in Ukraine has also affected the security of supply. It is there argued that introducing circular products and keeping the resources for a longer time would reduce their reliance on a continuous supply (Central Denmark Region, Sustainable Procurement Consultant, 2022; Region of Northern Denmark, Sustainability Consultant, 2022). In other words, an Economic, Financial, and Market driver for implementing the tools is that they have their own incentives for

introducing more circular products to ensure that they rely less on a continuous supply. This does however depend on whether or not the tools are able of supporting this.

5.3 Institutional and Regulatory barriers and drivers

One of the main institutional and regulatory barriers to adopting the tools is that it highly depends on the resources available. It relates to external factors on how resources are divided among the regions and how these are prioritised;

> Often it happens in such a way that the Capitol Region or Central Region often have more resources and money to develop something and then we sit and clap our hands when we after they have gained some good experience, get to use it.
>
> (Region of Northern Denmark, Sustainability Consultant, 2022)

As highlighted in the quotation some of the Regions highly rely on, and depend on the others' innovation. It can therefore be argued that some of the Regions would be more likely to adopt the tools than others. The current lack of adopting the tools among the Regions especially those with fewer resources could therefore also be explained by a general missing experience with the tools within the Regions. Thus, the adoption of the tools just by one or two Regions could therefore be seen as an institutional and regulatory driver for increasing the general adoption. It is also highlighted by one of the respondents that a regulatory approach could strengthen the implementation;

> If a requirement is set, for example, that within a five-year period, five tenders must be carried out that all include TCO. The purchasing managers would then agree on what should be done in the Northern Region and what should be done by the Capital Region and so on. Such an approach might work because that is how it works in other situations and you would then get it started and have it tested.
>
> (Region of Northern Denmark, Tender Consultant, 2022)

It is however further argued that a request for such an approach would be that someone in the top management is encouraging it to make it happen. In general, it is viewed among the respondents that the involvement and decision made by the top management are crucial for the adoption of the tools. This both relates to the policies as well as the decisions made in practice;

> we have had the challenge that we within our procurement department only can do what we have the mandate to do and that mandate we are given from our procurement policy. Our procurement policy has until now not left us with a lot of

> space for including sustainability, it has been changed a little bit but is still unclear how much.
>
> (Region Zealand, Tender Consultant, 2022)

As stated in the quotation in general the adoption can be hindered by missing policies which indicates that more structural changes are needed to enable the adoption of the tools. Having the top management's support can therefore been seen as an institutional and regulatory driver, as this would increase the adopting. This is also highlighted in the following as despite having a political mandate that could be seen as an institutional and regulatory driver for adopting the tool, it is not always the case. It is highlighted by one of the respondents that it in the end still on the top management;

> It is decided in advance which product areas can include sustainability requirements, but in the end, it is up to the purchasing manager to decide which tenders we can include green or circular criteria.
>
> (Central Denmark Region, Sustainable Procurement Consultant, 2022)

Misaligned policies are viewed as one of the major institutional and regulatory barriers to being able to benefit from the tools. Despite the tools being adopted and used in relation to support circular procurement the implementation would still depend on the technical systems available in the hospitals as highlighted in section 5.1. This is also emphasised by one of the respondents as being related to misaligned policies and strategies through time;

> The regional council is sometimes replaced and it can result in that after four years then there might be a change in the position on what needs to be the focus and what needs to be invested in. In the old days, we actually used a lot more multiple-use equipment (...) but then all of a sudden someone suggested, well, it's much better to switch to disposable because it is easier, it is cheaper, and it is faster out in the departments (...) and now you stand, here again, wanting to return to multiple-use since it is better for the environment, but we no longer have the capability..
>
> (Region of Northern Denmark, Tender Consultant, 2022)

As highlighted in the quotation the adoption of the tools does not only rely on the current policies and strategies but is affected by previous strategies. It can therefore be viewed that despite current policies within the procurement departments being changed allowing to include the tools the possibility of introducing for example multiple-use products compared to single-use would still be influenced by old policies and strategies.

5.4 Social and Cultural barriers and drivers

One of the main social and cultural barriers to adopting the tools can be linked to the perception of what a purchaser's job entails and rigidity in the procurement department. This is among others highlighted by the respondent from Region Zealand;

> As a purchaser we are employed to make as many tenders as we can handle, so we cannot go in and do what is ahead of that. That is, such as a life cycle analysis or (...) finding the right sustainable or best sustainable solution or in general the overall sustainability considerations we can not really go into and spend time on, as we are placed within procurement.
>
> (Region Zealand, Tender Consultant, 2022)

In general, it is viewed that adopting the tools would require that the purchaser changes their business routines and tasks which is not something that just happens. This is the case as each department are focused on the tasks and code of practices. This non flexible design of the departments entails that the introduction of the tools is difficult as it goes beyond their current tasks. The respondent from Region of Southern Denmark agrees that a change in the business routines is inevitable, however, it is not something that seems to be able to occur within the time of a tender;

> When a contract is about to expire and we need to make a new tender/contract, such as for diapers, we try to think of something innovative during that time, but going from single-use to multiple-use is a significant change. So, it should be done as pilot projects and that is not something we do now. We have an idea that we would like to, but because it is so new in our department and it is about behavioural changes, it is not something we can achieve in a tender period, so it is something that we will have to do additionally.
>
> (Region of Southern Denmark, Sustainable Procurement Consultant, 2022)

The respondent here highlights that considering more radically products and seeking to implement these requires a new way of thinking and a change of peoples practice both within their own department but also the end-users. This goes far beyond the current business practices within the procurement and would therefore require that it is done as pilot projects. These behavioural changes also relates to how they approach the tenders, as they only consider the products that need to be bought and not the function it needs to provide. This is critical in order to adopt the tools for circular procurement, as despite the tools are product-specific tools it still requires that the need is considered in order to use the tools. This

includes that the purchaser will have to understand the need of the end-users as well as what can be provided by the market. These behavioural changes are also something that the Central Region have considered in relation to implementing the tools;

> If we were to use the currently available tools then I think it would be the tender consultants that would collect the data, but in the beginning, it would be done with support from the sustainability team to ensure the purchaser knows how to collect the data and fill out the tool. This is also the case with the new tool, it would be us, the sustainability team within procurement, that would start to gain knowledge on the tools and then seek to implement it among the tender consultants.
>
> (Central Denmark Region, Sustainable Procurement Consultant, 2022)

Derived from the above a main social and cultural driver for adopting the tools could be to have a sustainability team within the procurement department. This both relates to having a team that has resources and time to learn how to use the tools, but also seeking to change the business routines. Moreover, this would also entail that the purchaser is guided on how to change their current practices. It is also argued by the sustainability consultant from Region of Northern Denmark, that if not placed within procurement it should at least be established in such way that ensures collaboration across the departments (Region of Northern Denmark, Sustainability Consultant, 2022).

5.5 Sub-conclusion

The identified barriers and drivers for adopting the TCO-tools within the Danish Region for circular procurement can be summarised as following. They are presented based upon the four conceptual-driven codes that guided the coding;

	Factors	Barriers	Drivers
Hard factors	Technical	- Complex organisational systems (patient care, hygiene, and limited capacity) - Lack of competencies	- Fitted for the organisation - Resources are allocated for training of the employees
	Economic/ financial/ Market	- Lack of information from suppliers - Depending on the relevance of product areas - Budget constraints	- Streamlining the requirements for suppliers - Uncertainty on continuously supply
Soft factors	Institutional/ Regulatory	- Missing political mandate - Misaligned policies and strategies - Lack of incentives from Top Management	- Legal requirements on using the tools - Learning from experiences with the tools externally
	Social/ Cultural	- Rigidity of the procurement departments - Behavioural changes	- Internal collaboration across different teams

Table 5.1 A overview of the main driver and barriers on utilising TCO-tool for circular public procurement. Own illustration adopted by (Jesus & Mendonça, 2017)

Complex organisational systems is viewed as a technical barrier that results in that the TCO-tools are not really considered in the regions. This includes an assumption of that their systems are too complex for the tools. However, this could be strengthen if they are able of learning from other similar organisation entailing that experiences are shared externally. Moreover, the implementation of the tools for CPP is also viewed as a process that requires that they will need to go beyond current practices which is currently not possible for several of the regions do to *Rigidity of the procurement department* and a lack of time and resources. This correlates with a missing incentives from the top management and that strategies and policies currently hinders the adoption. It is also viewed that the despite the tools could provide savings in the long do current budgets constrain hindering the adoption. This includes that they are accessed on what they save here and now entailing buying the cheapest product based upon purchasing price. This therefore do not correlates with a potential high purchasing price of etc. more resource efficient products that would pay themselves back. The current experiences with TCO-tools in the Regions is therefore also low and almost non-existing.

6 Recommendations

The purpose of this chapter is to provide some recommendations based on the two analyses; TCO-tools in theory and TCO-tools in practice. Thus the recommendations are based on how the tools support different R-strategies as well as which barriers and drivers exist for using the tools in the practice. Doing so also highlight how the TCO-tools could further support Circular Public Procurement (CPP) answering sub-question 3. The recommendations are made for the Danish EPA and the Danish Regions. The rationale behind this is that based upon the findings in the analyses it was discovered that whether or not the TCO-tools supports CPP depends on both on changes within the Danish Regions as well the design of the tools.

6.1 Recommendations for the Danish EPA

6.1.1 Recommendation 1: A less flexible design of the tools

It can be recommended that the tools should be designed with a minimum flexible design implying that the user will have minimal opportunities to adjust the tools themselves. Such an approach could strengthen the willingness of suppliers of providing the required data for tools. It is the case as they will have to use fewer resources if they are met by uniform requirements that do not depend on the individual organisations. This would also influence how the tools supports the R-strategy as it would have to depend less on the user, entailing that the R-strategy will have to be more directly supported.

6.1.2 Recommendation 2: Continue to develop a screening tool and a connecting TCO-tool

It is recommended that future tools should be designed similar to the new tool for textile. A such approach ensures that multiple R-strategies are directly supported not depended on the user as well as more upper rate R-strategies such as *refuse* can be supported. In addition to this could it also enable the introduction of for example multiple-use products or other radically product different from what is normally procured in the organisation. This is the case as its prior to a potential

buy is possible to show the top management that a such product would reduce the environmental impacts as well as the related costs.

6.1.3 Recommendation 3: Avoid silo-thinking and develop the tool for the intended user

It is recommended that the tools are developed together with the intended user as when it is to be used for CPP it requires that the system of the organisation is reflected in the tools. When the tools are not designed for the system it requires to many resources and competencies of the user to adjust themselves which can result in that the tools are not applied. It implies that the tool needs to both reflect the market for the specific product as well as the intended users of the tool. This would also entail that the tool supports the R-strategy more directly.

6.2 Recommendations for the Danish Regions

6.2.1 Recommendation 1: Involvement of Top Management

The Danish Regions should ensure that the tools are implemented with the support of top management. If top management does not understand and believe in the tools' ability to assist CPP, they will not be implemented. Top management should set aside resources and time to train relevant employees. Furthermore, the management should strive to break down the procurement department's rigidity in order to promote the adoption of CPP tools. This pertains to the fact that using the tools for CPP necessitates the purchaser going beyond present procedures and tasks. It also includes establishing internal collaboration. It is argued that this might be accomplished by either increasing existing departmental linkages or by mixing departments, such as establishing a sustainability team within procurement.

6.2.2 Recommendation 2: Increase knowledge on the potentials of the TCO-tools

It is strongly suggested that the Regions communicate with one another on their experiences using the tools externally. This not only pertains to expanding one's knowledge on how to apply the tools, but it also has the potential to ensure that the tools are adopted in a manner that is consistent with one another, so ensuring that uniform requirements are established for suppliers. This is extremely important because even while the new tool for textile depends less on the user, it is still

flexible in terms of converting the findings that come up during the screening process into criteria.

Discussion 7

7.1 Case study

This aim of this thesis has been to investigate the potential of the Danish Environmental Agency's TCO-tools to support CPP. For doing so a case study of the Danish Regions was conducted based upon an information-oriented case selection. In order to achieve this aim, a case study of the regions of Denmark was carried out using an information-oriented case selection as the foundation. When compared to other public organisations, such as municipalities, the inclusion of Danish regions provided opportunities to investigate and comprehend the newly developed TCO tools by the Danish Environmental Protection Agency (EPA). This consists of their newly developed TCO tools that are designed specifically for multiple-use hospital textiles. These tools include a screening tool as well as a TCO tool for the tendering process.

The use of a single-holistic case design, which requires the case to be investigated as a single entity, was chosen. The fact that the final region, the Capital Region, could not be included is therefore something that can be considered problematic. However, the question of whether or not it would have had an impact on the results is open. According to the responses received from respondents of the other regions, the Capital Region possesses a greater number of resources, which may suggest that they are in a better position to make use of the TCO-tool for the CPP. On the other hand, the Central Region of Denmark is in a situation very similar to this one, in which the lack of resources is not an issue, but they have not used the tools up until this point. Since the differences in resources have already been accounted for, it is possible to reach the conclusion that the Regions that have already been included are presentable. Further, one could make the case that including the Capital Regions would have enabled the identification of a variety of additional barriers and drivers. On the other hand, the fact that the various respondents were in agreement about several of the barriers suggests that they are not specific to any one organisation but rather represent an overarching barrier.

7.2 TCO-tools for Circular Public Procurement in theory and in practice?

Based on the findings in chapter 4, it is possible to conclude that tools can support several R-strategies, some more directly than others. In general, because several R-strategies are covered, it can be argued that the tools have the potential to support CPP. However, the currently existing tools are primarily dependent on how they are used to support R-strategies. For example, existing tools can support *Rethink* so that users can understand and consider whether leasing or renting is a better option than purchasing. However, the user must conduct an additional assessment and determine whether new workflows or practices are required and include these in the calculation. In comparison to the existing tool, the new textile tool incorporates more system-thinking, which also allows for the attainment of higher rate strategies. Not only are the workflows more explicitly stated, but it also includes how these are changing when moving to a more radical product. It implies that by using the tools, it is not dependent on the user whether or not *Refuse* can be supported, as it is supported simply by filling out the tool itself. It should however be noted that whether or a more radical product is chosen depends on the analysis.

In addition, derived from the findings in chapter 5 do the using tools not equal that it in practice leads CPP. This among others can be linked to both some more hard factors such e.g. lack of training and budget constrains as well as some more soft factors such as e.g. a rigidity of the procurement department and misaligned policies. It can therefore be argued that using the TCO-tools for CPP depends on that the right conditions are in place in the organisation. This is especially valid when the tools can support the upper-rate R-strategies. Here it seems that the competencies and resources needed are increasing as well as the more technical conditions needs to be there.

Conclusion 8

The objective of this research is to investigate the theoretical and practical implications of the Danish EPA's TCO-tools for supporting CPP. This is because the Danish government has identified them as potential tools to facilitate circular procurement. However, current research suggests that their application in CPP may be limited, as well as a low acceptance of the tools. Thus, the following research question has been formulated;

What is the potential of the Danish Environmental Protection Agency's TCO-tools to support Circular Public Procurement?

The research question is answered in two sub-analyses.

The first analysis is to answer the potential of the TCO-tools to support CPP from a theoretically point of view. For this analysis an analytical framework was composed. Here the R-framework developed by Potting et al. (2017) are used to understand how well the tools supports the R-strategies based upon the evaluation criteria; supported, indirectly supported and not supported. The analysed TCO-tools in this thesis consists of the already existing TCO-tools as well as the a coming TCO-tool for hospital textiles. The last mentioned consists of both a screening tool as well as a connecting TCO-tool. From the analysis is can be concluded that the tools can support several of the R-strategies. Mutual for all of the tools is that they all directly support the R-strategy *Reduce*. Moreover, moving from the existing tools to the new screening tool can the upper-rate R-strategy *refuse* be directly supported, entailing an increasing circularity and system-thinking. The screening tool compared to the existing tools do in general entail that the R-strategy are more directly supported implying less depends on the user. It further includes the environmental impacts and costs from the entire life-cycle.

The second analysis is to answer the potential of the TCO-tools to support CPP from a practically point of view. Here a qualitative single-holistic case study of

the Danish Regions is conducted. Based upon coding of four semi-structured interviews with the Danish Regions several barriers and driver for adopting the TCO-tools for CPP was identified, which are summarised below;

	Factors	Barriers	Drivers
Hard factors	Technical	- Complex organisational systems (patient care, hygiene, and limited capacity) - Lack of competencies	- Fitted for the organisation - Resources are allocated for training of the employees
	Economic/ financial/ Market	- Lack of information from suppliers - Depending on the relevance of product areas - Budget constraints	- Streamlining the requirements for suppliers - Uncertainty on continuously supply
Soft factors	Institutional/ Regulatory	- Missing political mandate - Misaligned policies and strategies - Lack of incentives from Top Management	- Legal requirements on using the tools - Learning from experiences with the tools externally
	Social/ Cultural	- Rigidity of the procurement departments - Behavioural changes	- Internal collaboration across different teams

Table 8.1 A overview of the main driver and barriers on utilising TCO-tool for circular public procurement.

Based upon the above it is therefore concluded if the TCO-tools are to support CPP it highly depends on whether or not that the right conditions are established in the Public Organisation. Theoretically, the TCO-tools could support CPP, but in practice it depends on whether the organisation can align its policies, strategies, and practices with a TCO perspective and allocate the needed resources.

It is therefore also suggested that the potential of using the TCO-tools for CPP, could be further supported, by following these recommendations; **For the Danish EPA:** 1) A less flexible design of the tools, 2) Continue to develop a screening tool and a connecting TCO-tool, 3) Avoid silo-thinking and develop the tools for intended user. **For the Danish Regions:** 1) Ensure involvement of Top Management 2) Increase knowledge on the potentials of TCO-tools.

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Interviewguides A

A.1 Interviewguide for the Danish Regions (North, South, Zealand)

1. **Kort omkring din/Jeres stilling**
2. **Cirkulære indkøb:**
    - Har I fokus på cirkulære indkøb?
        - Hvis ja, hvordan?
        - Hvordan er det organiseret?
3. **Spørgsmål vedrørende TCO**
    - Hvad er jeres brug af TCO?
        - Hvis brug:
            * Bruges det i forbindelse med cirkulære indkøb?
            * For hvilke produktkategorier?
            * Hvor stor betydning har TCO i udbuddet?
            * Hvem laver forarbejdet i forhold til at indhente data for TCO, er det indkøber og/eller konsulenter?
        - Hvis ingen brug, så hvorfor?
    - Mener Du/I der er behov for udvikling af TCO-værktøjer i forhold til at kunne udføre cirkulære indkøb?
        - Hvordan ville det passe ind i Jeres nuværende indkøbsprocesser?
        - Hvem ville skulle sidde med det?
        - Hvordan ville et sådan værktøj skulle kunne bruges for at være kunne hjælpe jeres indkøbsproces i forhold til cirkulære indkøb?
4. **Værktøjer til grønne/cirkulære indkøb**
    - Har I selv udviklet lignende værktøjer?

A.2 Interviewguide for the Central Region Denmark

1. **Kort omkring din stilling**
2. **Cirkulære indkøb:**
    - Har I fokus på cirkulære indkøb?
        - Hvis ja, hvordan?
        - Hvordan er det organiseret?
3. **Spørgsmål vedrørende TCO**
    - Hvad er jeres brug af TCO på nuværende tidspunkt?
        - Hvis brug:
            * Bruges det i forbindelse med cirkulære indkøb?
            * For hvilke produktkategorier?
            * Hvor stor betydning har TCO i udbuddet?
            * Hvem laver forarbejdet i forhold til at indhente data for TCO, er det indkøber og/eller konsulenter?
        - Hvis ingen brug, så hvorfor?
    - Nyt TCO værktøj for tekstiler
        - Hvordan skal det nye værktøj implementeres i jeres organisation?
        - Hvordan vil det passe ind i jeres nuværende indkøbsprocesser?
        - Hvem ville skulle sidde med det?
        - Hvilke udfordringer ser Du på nuværende tidspunkt med implementeringen?
        - Hvilket potentiale ser Du for at værktøjet er udviklet, som et to-delt værktøj i forhold til at øge brugen af TCO?

Screeningtool B

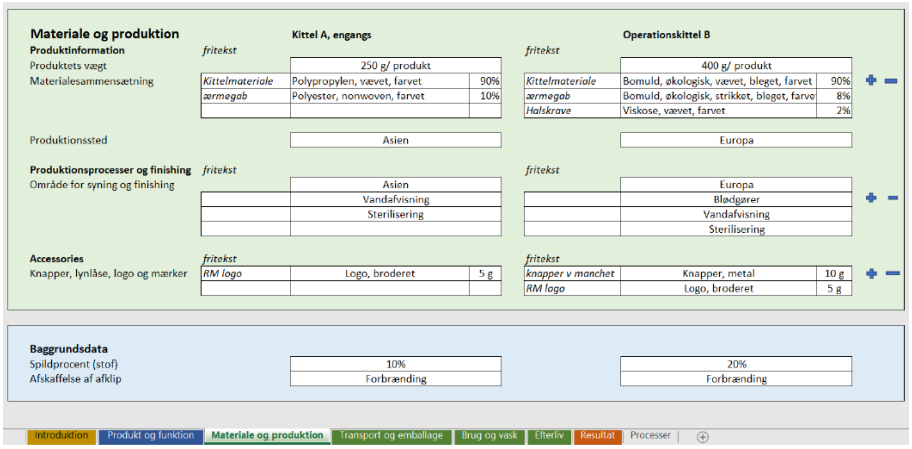

Figure B.1 A screenshot from the coming screening tool, illustrating the sheet for including information related to materials and production. Source: (CDR & Danish EPA, 2022).

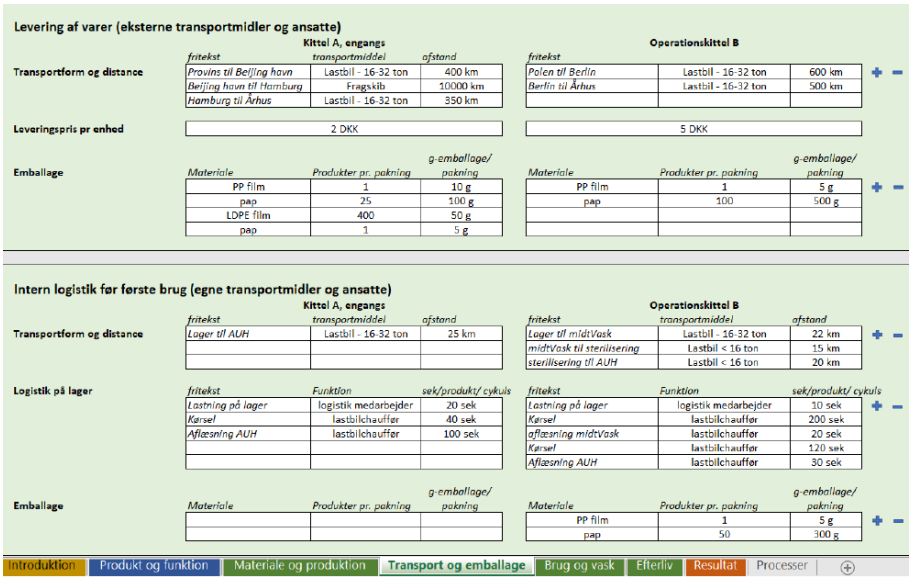

Figure B.2 A screenshot from the coming screening tool, illustrating the sheet for including information related transportation of the product for delivering the product, as well as the internal transportation prior to first use. Furthermore, information related to the packaging. Source: (CDR & Danish EPA, 2022).

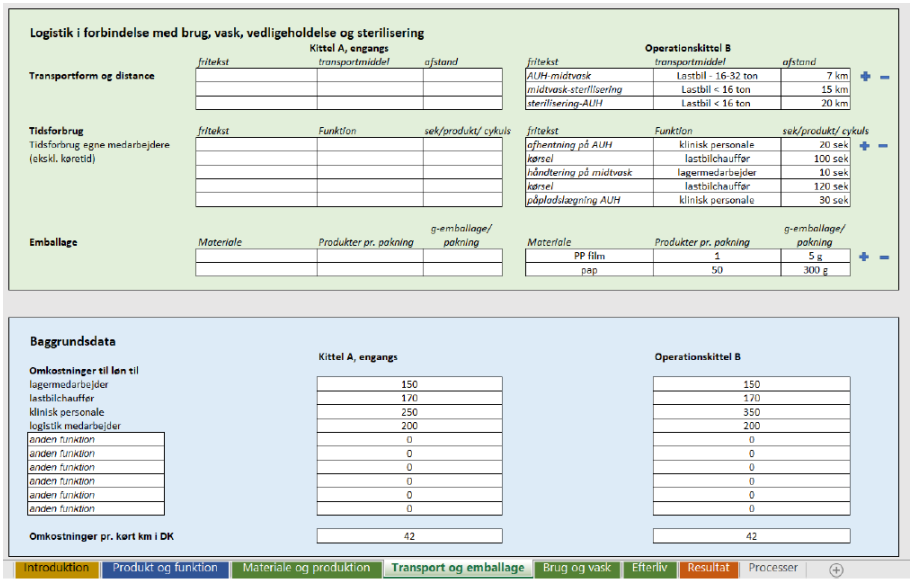

Figure B.3 A screenshot from the coming screening tool, illustrating the sheet for including information on costs in relation to the laundry service and use as well as the specification on the laundry service. This also includes if the textile needs some re-impregnation. Source: (CDR & Danish EPA, 2022).

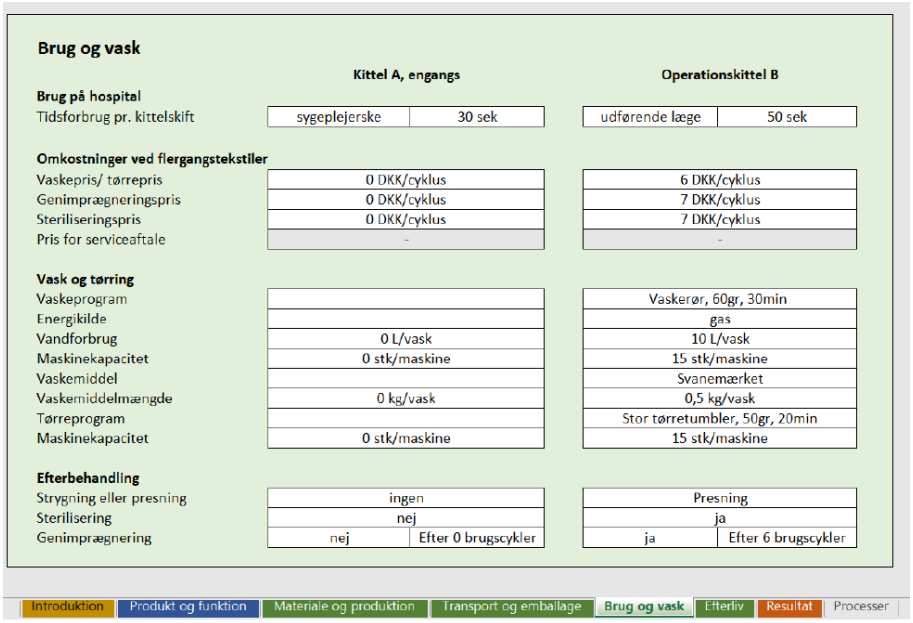

Figure B.4 A screenshot from the coming screening tool, illustrating the sheet for including information related labour costs in relation to the laundry service and use. Source: (CDR & Danish EPA, 2022).

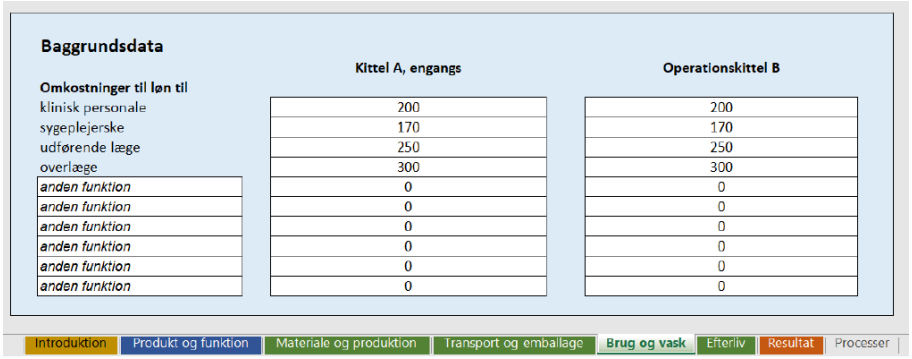

Figure B.5 A screenshot from the coming screening tool, illustrating the sheet for including information related end-of-life both for packaging and the textile. Source: (CDR & Danish EPA, 2022).