

FROM WASTE TO RESOURCES

THE ROLE OF A MUNICIPAL WASTE MANAGEMENT COMPANY IN CIRCULAR ECONOMY

by

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CV

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ENGLISH SUMMARY

The aim of this PhD is to gain a deeper understanding of the role that municipal waste management companies and authorities can play in the transition to a circular economy. Waste management has so far played the role of reducing the environmental impacts from waste, but as awareness of the limits of earth's resources grows, waste management must additionally play the role of bouncing back resources into the production-consumption system with a reducing effect on natural resource extraction. From being waste managers, actors within the waste sector are going to become resource recovers.

Recent regulatory requirement to increase recycling has pushed municipalities in Denmark to develop and implement solutions that deviate waste management away from the so far dominant waste treatment solution, i.e. incineration, towards recycling. Other environmentally superior solutions such as waste prevention and reuse, however, play a limited role in today's waste regulation and are rather rare in the practical management of waste, as only recycling and recover strategies are pursued.

The concept of the circular economy provides a new discursive framework for understanding waste resources, and this can inspire waste managers to develop new business models that aims to create value from waste rather than simply aiming for a cost-efficient waste treatment.

This study is an ethnographic field study, which investigates practical experiments and innovation processes in a municipal waste management company in Denmark aiming to develop more sustainable solutions. Through a joining of literature reviews, interviews, company economic data, waste data, ethnographic interviews and participatory observations the study investigates

1. How waste prevention can be conceptualized and integrated into the municipal waste management
2. The socio-technical and business potentials and barriers for developing new waste management solutions in which post-consumer products are prepared and sold for reuse
3. The local value creation potentials from these prevention and reuse related activities (value understood broadly as covering both economic, environmental and social value)
4. How the internal working practices in the case company support or hinder sustainable and circular waste management.

These questions are addressed in four distinct research articles and supplemented with case study narratives from the innovation processes that has taken place in the case company, AVV, from its formation in 1988 to its launch of the refurbishment commercial foundation, Godt gjort in November 2017.

The first overall finding is that AVV is an extreme case in which innovation for sustainability has always taken place in spite of infrastructural bindings to the incineration technology. This is assessed to stem from a particular organizational culture, certain organizational values and meanings, and not least managers, employees and board members with motivation, competences and values that support a “Moving up the waste hierarchy”. The case is extreme and deviates from the average municipal waste company. Because of this, AVV and its practical experimentations can provide valuable learnings and insights into the barriers and possibilities for integration of prevention, preparation for reuse, refurbishment and recycling into municipal waste management in general.

The first research article consists of a literature review of waste prevention from the perspective of the local waste management. This study suggests how knowledge on waste prevention behaviors, methods and benefits can be used by local waste management to design waste prevention initiatives. The two main types of prevention methods are citizen communication and awareness campaigns and solutions that enable reuse, such as operating a reuse shop. A need for better institutional incentive structures and regulatory support for waste prevention and reuse is also identified and recommended.

The second research article focusses on reuse of one particular post-consumer product group, i.e. Waste Electrical and Electronic Equipment (WEEE). WEEE is regulated differently than other waste types, among other with an extended producer responsibility scheme. In theory, this regulatory framework should incentive and enable reuse, but the study finds that it does the opposite by directing waste management along one trajectory, i.e. recycling. In the study, we clarify the perspectives of all the major stakeholder groups in the system in order to find constraints and opportunities to integrate preparation for reuse as a waste management solution supplementary to recycling.

Following this research article is a case study narrative of how WEEE has been managed in AVV, and how AVV has made several attempts to integrate refurbishment of WEEE into the local waste management. Due to conflicting interests in the system, refurbishment of WEEE has not yet been implemented. A bargaining and negotiation process is taking place among AVV, producer responsibility schemes, the Confederation of Danish Industry, a local engineer, and the municipality about how to establish a strategic niche experiment that can provide learning about the means to develop circular business models, i.e. how WEEE can

be refurbished and what the final goal should be, i.e. which constellation of actors should operate the circular business model in the future.

The third research article investigates the value creation potential in AVV of increasing the separate collection of reusable and recyclable waste types at the recycling centers and preparing them for reuse and recycling respectively. This study draws upon quantitative data collected in AVV in the period from May 2016 to November 2016. This study highlights how limited the value capture from recyclable waste actually is from a local perspective compared to the value that can be created from preparing post-consumer products for reuse. Preparing post-consumer products for reuse can create local jobs.

This study is followed by a second case study narrative from AVVs innovation journey which has resulted in the establishment of a refurbishment workshop called Godt gjort. Bikes, textiles and bricks are refurbished and sold as products rather than being material or energy recovered. This narrative illustrates how AVV has always experimented and innovated for a sustainable development. It also shows how the concept of the circular economy supports these existing competences and ways of experimenting, and becomes a way to rethink the prevention and reuse activities and consider the waste hierarchy in a more reflected way. The circular economy concept has contributed with new ideas about making products from waste and collaborating with new types of partners. Mainly, it has placed a more distinct emphasis on the value of the inner circles (preparation for reuse) and thus contributed to making evident how the waste hierarchy can be prioritized in practice and integrated into the legal framework for waste management.

The final research article investigates the working practices at AVVs recycling centers. Citizens can enable the circular economy when they conduct the first value adding input to the circular processes of waste management by separating the waste correctly. The employees at the recycling centers are ambassadors for AVVs new circular business models and they hold a key position in the relationship to the citizens. The main findings of this study is that not all working practices are equally appropriate in encouraging higher reuse and recycling rates. The study points towards organizational practices in AVV that could be changed in order to better support the transition to a circular economy.

Based on these results, the main contribution of this thesis is its provision of a better understanding of the possibilities and barriers to integrate circular solutions, i.e. waste prevention, reuse, refurbishment and recycling, into the municipal waste management and thus loosen the dependence on waste incineration. The study points towards the importance of experimentation in protected niches in order to support learning for all regime actors. On a similar note, it points towards the necessity of engaging new types of collaborations with different actors in the process of

developing circular business models. This requires skills for bargaining and negotiating in order to create value for all stakeholders.

The main opportunities are found to be in considering value broadly, i.e. in terms of both economic, environmental and social benefits, and additionally considering this value creation from a systemic rather than an individual business perspective.

DANSK RESUME

Formålet med dette PhD studie er at øge forståelsen for, hvilken rolle kommuner og de kommunale affaldsselskaber kan spille i omstillingen af affaldshåndteringen til en mere cirkulær økonomi. Hidtil har affaldsbehandlingen primært sigtet mod at reducere de negative miljøpåvirkninger fra affaldet, men tiltagende opmærksomhed på presset på jordens ressourcer har betydet, at aktører i affaldssektoren i højere grad skal spille en rolle som ressourceforvaltere, der muliggør en mere effektiv udnyttelse af ressourcerne i affaldet. Fra at være affaldsbehandlere skal de blive ressourceforvaltere.

Europæisk affaldslovgivning pålægger medlemsstaterne at øge indsamlingen af affald til genanvendelse, og dette har udfordret de danske kommuner til at udvikle nye løsninger til opnåelse af disse krav, så mindre affald i fremtiden skal brændes og mere materiale genanvendes. Der findes dog andre miljømæssigt mere efterstræbelsesværdige affaldsløsninger end genanvendelse; affaldsforebyggelse og genbrug. Disse spiller i praksis sjældent en rolle i affaldshåndteringen, og fra lovgivningens side tilskyndes ikke til hverken forebyggelse eller genbrug i regi af kommuner og affaldsselskaber.

Konceptet om den cirkulære økonomi giver en ny diskursiv ramme for forståelsen af affald som ressource, og tanken bag dette projekt har været, at undersøge om dette koncept kan inspirere affaldsbehandlere til at udvikle nye forretningsmodeller, hvor målet er at skabe øget værdi af affaldet fremfor udelukkende at sigte mod en omkostningseffektiv og miljøvenlig behandling.

PhD studiet er et etnografisk feltstudie, som følger og undersøger praktiske eksperimenter og innovationsprocesser i et kommunalt affaldsselskab i Danmark, Affaldsselskabet Vendsyssel Vest I/S. Gennem en sammenføjning af litteraturstudier, interviews, økonomiske data, affaldsdata, etnografiske interviews og deltagende observation er følgende underspørgsmål blevet undersøgt:

1. Hvordan kan affaldsforebyggelse forstås og konceptualiseres, og hvordan kan forebyggelse integreres i den kommunale affaldshåndtering?
2. Hvad er potentialerne og barriererne fra hhv. et forretningsmæssigt og et socio-teknisk perspektiv for udvikling af metoder til forberedelse med henblik på genbrug af produkter leveret til affald?
3. Hvordan er værdiskabelsespotentialet fra øget separat indsamling, forberedelse og salg af affald til genbrug og genanvendelse (hvor værdi forstås bredt som dækkende de tre bæredygtighedssøjler, dvs. økonomiske, sociale og miljømæssige effekter)?

4. Hvordan kan de interne daglige praksisser i organisationen hhv. understøtte eller hindre udviklingen af mere bæredygtige og cirkulære affaldshåndteringsmetoder?

Disse spørgsmål adresseres i fire videnskabelige artikler og suppleres af et fortløbende casestudie narrativ af innovationsprocessen i AVV fra dets dannelse i 1988 til etableringen af Godt gjort i november 2017, en erhvervsdrivende fond i hvilken affald omdannes til ressourcer gennem istandsættelse og genfremstilling af produkter.

Den første overordnede pointe er, at AVV er en ekstrem eller en afvigende case idet dens engagement i innovation for affaldsforebyggelse og genbrug afviger fra det gennemsnitlige affaldsselskabs eller kommunes. På trods af infrastrukturelle bindinger til forbrændingsanlæg og energisektoren har AVV siden dets dannelse arbejdet med de øvre niveauer af affaldshierarkiet. Dette vurderes at skyldes den herskende organisationskultur, som er præget af værdier og meninger, som understøtter innovation for bæredygtighed. Ikke mindst er og har der i AVV været nogle gennemgående personligheder, som har motiveret til fortløbende innovation og udvikling af løsninger længere oppe i affaldshierarkiet. AVV som case er derfor interessant at følge, fordi den via de praktiske eksperimenter kan afsløre hvilke barrierer, der er for at arbejde med forebyggelse og genbrug i praksis, samt hvilke faktorer der gør det muligt og som understøtter dette arbejde.

Den første artikel er baseret på et litteraturstudie af affaldsforebyggelse set fra et lokalt affaldshåndteringsperspektiv. Dette studie peger på, hvordan viden om borgeres affaldspraksisser, om forebyggelsesmetoder og om de miljømæssige fordele ved forebyggelse kan anvendes til at designe lokale løsninger for affaldsforebyggelse. Overordnet peges der på to metoder: for det første kommunikative og borgerinvolverende kampagner og løsninger, og for det andet etableringen af løsninger, der gør det muligt for borgere at genbruge (et konkret eksempel er AVVs genbrugsbutik). Studiet peger dog også på, at der er behov for etableringen af nogle incitamentstrukturer og politisk support, såsom lovliggørelse (eller krav om) af at anvende en del affaldsgebyret til forebyggende aktiviteter, samt klare politiske udmeldinger om kommunernes og affaldsselskabernes ret til at drive genbrugsbutikker.

Den anden artikel fokuserer på en bestemt affaldstype, nemlig affald fra elektrisk og elektronisk udstyr, også kaldet WEEE. WEEE bliver reguleret anderledes end andre forbrugerprodukter, bl.a. er det omfattet af et producentansvarssystem. I teorien skulle dette system sikre en høj grad af genbrug og genanvendelse, men i praksis låser det systemet til et spor, nemlig materialegenanvendelse. I dette studie afdækkes de involverede aktørers interesser, og der peges på en række barrierer, men også muligheder for at integrere forberedelse til genbrug i systemet.

I forlængelse af dette studie præsenteres et casestudie narrativ fra AVV omhandlende AVVs forsøg på at etablere et værksted for reparation af WEEE. Pga. gældende lovgivning og interessekonflikter i systemet har det endnu ikke været muligt at etablere dette. En proces foregår med forhandlinger mellem AVV, producentansvarsordninger, Dansk industri, en lokal elektriker og Hjørring kommunes job center om etableringen af et værksted. Analysen heraf peger på, at etableringen af et strategisk niche eksperiment (fremfor bare et værksted) kan medføre læring og vigtig ny viden om midlerne og metoderne til at udvikle cirkulære forretningsmodeller, samt om hvordan disse forretningsmodeller kan se ud i en endelig fremtidig version.

Den tredje artikel undersøger værdiskabelsespotentialer fra øget indsamling af affald til genbrug og genanvendelse. Overraskende viser det sig, at den affaldsfraktion der kan øges mest er produkter til genbrug. Denne fraktion er desuden volumenmæssigt større end fx affaldsfraktionerne papir og plastik. Studiet viser, at der kun kan skabes begrænset øget værdi (lokal økonomisk, social og miljømæssigt), hvis overhovedet noget, ved indsamling til genanvendelse, hvorimod indsamlingen og salget af produkter til genbrug bidrager både til den sociale, økonomiske og miljømæssige bundlinje.

Dette studie efterfølges af endnu et casestudie narrativ fra AVVs innovationsrejse frem mod dannelsen af Godt gjort. Cykler, tekstiler, mursten m.m. istandsættes og klargøres til salg som nye produkter. Dette narrativ illustrerer, hvordan AVV altid har eksperimenteret for en bæredygtig udvikling. Det viser også, hvordan konceptet om den cirkulære økonomi understøtter denne eksperimenteren og bliver en måde at gentænke forebyggelse og genbrug på, samt bidrager til en ny og mere reflekteret anvendelse af affaldshierarkiet som mental model. Cirkulær økonomikonceptet har bidraget med nye ideer omkring det at udvikle produkter af affald, samt det at igangsætte samarbejder med andre markedsaktører omkring dannelsen af nye forretningsmodeller og partnerskaber.

Den sidste artikel omhandler de daglige praksisser i organisationen AVV og undersøger hvordan de hhv. understøtter eller forhindrer en god sortering til genanvendelse og genbrug. Udgangspunktet er, at borgernes sortering er afgørende for, hvilke muligheder et affaldsselskab har for at skabe cirkulære forretningsmodeller. Borgernes kontaktflade til AVV er genbrugsstationerne, og her møder borgerne de ansatte, som skal hjælpe og vejlede dem i korrekt sortering. De ansatte på genbrugspladserne er således ambassadører for AVVs cirkulære forretninger og spiller dermed en afgørende rolle i forholdet til borgerne. Dette studie peger på nogle muligheder for at ændre de interne praksisser til bedre at understøtte dette.

Baseret på disse resultater, er afhandlingens hovedbidrag en dybere forståelse af mulighederne og barriererne for at integrere affaldsforebyggelse, genbrug,

istandsættelse og genanvendelse i den kommunale affaldshåndtering og dermed løsne afhængighedsbåndet til forbrænding og energisektoren. Studiet peger på vigtigheden af at eksperimentere i beskyttede niches for at generere læring. I relation hertil peger studiet på vigtigheden af at indgå i nye samarbejds-konstellationer med forskellige aktører i processen omkring udviklingen af cirkulære forretningsmodeller. De nødvendige kompetencer og ressourcer findes ikke alene i hverken det enkelte affaldsselskab eller i andre typer virksomheder. Det er i samskabelsen af værdi, nøglen til nye cirkulære løsninger ligger. Derudover peger studiet på vigtigheden af at tilstræbe værdiskabelse i en bred forstand, dvs. både miljømæssig, socialt og økonomisk, samt at forstå denne værdi fra et systemperspektiv fremfor fra et individuelt forretningsperspektiv.

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CHAPTER 1. THE PROBLEM FIELD AND RESEARCH QUESTIONS

The concept of the circular economy has gained increased attention in recent years. The circular economy concept proposes a circular, more resource efficient alternative to the linear way we currently produce and consume things. In addition to increased resource efficiency, the circular economy is predicted to entail both environmental and economic benefits, and circular strategies are seen as potential for creating competitive business models. Research on the implementation of the concept of the circular economy is still in its emerging stages, but an increasing number of practical examples exist and have been presented e.g. by the Ellen MacArthur Foundation. So far, research within the subject of circular economy has mainly focused on the role of the industrial sector and product design. However, a circular economy requires systemic changes at all levels (Kirschherr, Reike, & Hekkert, 2017) and for this reason, a transition to a circular economy will have to engage all types of actors across the value chain. The role of other actors than manufacturing businesses is still unclear.

Today, the management of the resources in waste are conducted in the complex socio-technical system of waste management. This system and the role that it can play to support a transition to a circular economy is a less researched subject within the theme of the circular economy. Lewandowski (2016) points out that a *"heavily underexplored area is related to applying circularity to business models of public sector organizations"*. This thesis will explore the role of the waste management sector in the circular economy, more specifically the role of a municipal waste management company in Denmark. The thesis is about the processes that a municipal solid waste (MSW) management company, Affaldsselskabet Vendsyssel Vest I/S (AVV), has undergone in their attempts to transition their business towards a more sustainable and circular economy.

1.1. FROM MATERIAL RECYCLING TO PRODUCT LIFE EXTENSION

Waste management technologies and practices are continuously changing. Particularly in recent years, where the call for increased recycling have pushed the waste management sector to develop new solutions to replace the so far dominant treatment technologies of landfilling and incineration. As such, the waste management sector is already a part of the circular economy through its recycling activities, but the circular economy concept encompasses more than simply recycling of waste. In a circular economy, the value of the resources are retained for as long as possible. This implies that circular strategies for extension of product

lifetimes are applied before recycling and recovery of materials and energy from waste. These lifetime extending strategies include maintenance, repair, refurbishment, remanufacturing and other measures preparing products for reuse. Yet so far, these strategies have mainly been applied (in practice but particularly in conceptualizations of the Circular Economy) as part of business models in the manufacturing industry.

In Denmark, the waste management system infrastructure is well-established with one point of pick-up of waste from citizens. This means that all household waste is collected efficiently with increasing volumes directed for material recycling. However, circular measures for waste prevention and extension of product useful lifetimes have not been a regular and systematic part of the waste management. In fact, it is an ongoing political dispute whether municipal waste management in Denmark should take waste preventive measures and actively support product reuse. For this reason, experiences from a municipal waste management company actively pursuing circular economy strategies can contribute to an increased understanding of what considerations, challenges, and possibilities the process of developing and organizing product lifetime extending solutions implies. Through the study of this, the present PhD project aims to inspire local waste management authorities as well as to inform policy makers on the possibilities for integrating waste preventive and lifetime extending measures into the municipal waste management. Secondly, empirical evidence from a case study can make contributions to the concept of the circular economy by increasing the understanding of what an implementation of circular strategies requires from the perspective of waste management.

1.2. INDUSTRIAL PHD PROJECT

The research project is an industrial PhD project. An industrial PhD is a research project, which is conducted in a collaboration between a private sector company and a university. I have been employed as an industrial PhD student by the company AVV, and spent half my time in AVV and half my time at Aalborg University. An industrial PhD project aims at both scientific objectives as well as more development oriented and commercial goals for the case company. As part of the Innovation Fund Denmark's Industrial Researcher Program, it contributes to this Fund's overall purpose: *“creating growth and employment in Denmark”* (Innovation Fund Denmark, 2017).

1.2.1. AFFALDSSELSKABET VENDSYSSEL VEST I/S

AVV is a municipally owned company responsible for collecting and managing waste from 46,000 households in the two municipalities Hjørring and Brønderslev in the Northern Part of Jutland in Denmark. They manage the collection of the daily discard; they run 18 Recycling Centers where citizens can bring their used products and waste and sort them for reuse or recycling. AVV runs a waste incineration plant;

two landfills; and manage the collection of hazardous waste from industry. The collected waste, which is not incinerated or landfilled, is sold to other private actors for further treatment. Moreover, AVV runs a second-hand shop where the collected reusable items are sold. AVV also organizes and participates in other types of activities that reach beyond waste collection and treatment. This includes activities, which inform and inspire citizens and other actors about environmental and societal issues, art and culture, design and innovation with the aim of promoting waste as a resource more broadly (Kjærdsdam, Madsen, & Ørnbøl, 2013).

In this introductory chapter, I will describe how the PhD project was initiated. That story provides some insight into the identity of the case company AVV and the research community within which the project was developed. Subsequently, I present some reflections on the concept of waste and how waste and its management is placed within the wider context of our capitalist production and consumption society. How waste is managed differs among countries, and for this reason, I describe the broad lines of the Danish waste management system and how it is governed. Finally, I present the case company AVV, as a thorough insight into the company is a requisite for understanding the research conducted in the study.

1.2.2. THE INITIATION OF THE PHD PROJECT

In March 2012, AVV approached Aalborg University in order to establish a collaboration. The first email correspondence does not include explicit suggestions as to which themes this collaboration should be about. Minutes from the first meeting held in May 2012 reveal that the theme “waste to resources” was discussed among five other topics. More specifically, ideas about how AVV could inform designers and producers about how to design for the end-of-life phases and thus enable longer lifetimes and recyclability were discussed.

In January, AVV engaged a cooperation agreement with Aalborg University. The background for engaging this cooperation was that both partners, AVV and AAU, work with innovation and development within the field of waste- and environmental management, though from highly different perspectives. One of the aims of this cooperation agreement was to develop and establish environmentally friendly solutions and practices, which in the long run could be disseminated to other waste management authorities in Denmark. One of the more tangible outcomes of this cooperation agreement was the initiation of two industrial PhD projects, one of which was to be conducted by me.

At the time, I was employed as a research assistant in the research group “Sustainability, Innovation and Policy”. This group has a long tradition for working with eco-design and environmental management, and more recently, the concept of the circular economy has been adopted in the research. Methodologically, the group works problem-based and applies action research and close collaboration with

industry and organizations, thus always looking for companies to engage and collaborate with in sustainability related issues.

This dissertation presents the research from the industrial PhD project that I conducted in AVV from Dec. 2013 to Nov. 2017.

Before zooming in on the specific purposes and contents of the project, I will be zooming out to show how the project's problem field is placed within the wider context of the societal and environmental challenges related to today's consumption and production system.

1.3. WASTE AND ITS EMBEDDEDNESS IN A LINEAR PRODUCTION AND CONSUMPTION SYSTEM

During the last part of the 20th century, consumption levels grew substantially, partly due to increased affluence and partly due to population growth. A consequence of the increased consumption has been the generation of increasing amounts of waste.

1.3.1. ENVIRONMENTAL IMPACTS FROM WASTE AND LIMITS TO RESOURCE USE

The global system of production and consumption uses material resources in a way that is mostly linear (Boulding, 1966). This means that resources are extracted from nature, and then used as input for production of goods. After distribution and use, the products end as waste. At the time, when things are dumped as waste, the value of the materials within these waste products are at the lowest point in its lifetime. Hence, many places in the world, waste is dumped in landfills, which was also the case in Denmark not that many decades ago. Waste in landfills (and other inadequately handled waste) poses a threat to human health and causes environmental problems, and in order to handle these environmental problems, incineration of waste with energy recover was introduced in Denmark in the 1960s. Incineration soon became the dominant waste treatment solution in Denmark, and it more or less solved the problem with the pollution from waste in landfills. Out of sight, out of mind.

However, Earth is a closed system. A spaceship as Kenneth Boulding (1966) called it, and that only has a certain amount of resources available, and only has a certain assimilative capacity to restore new resources from waste. Today, global resource consumption exceeds Earth's carrying capacity to provide and restore resource (WWF, 2016). Waste management has until now played the role of reducing the environmental impacts from waste, but as awareness of the limits of earth's resources grows, waste management must play the role of bouncing back resources into the production-consumption system with a reducing effect on natural resource

extraction. From being waste managers, actors within the waste sector are going to become resource recoverers.

1.3.2. THE CIRCULAR ECONOMY AS A MORE SUSTAINABLE ALTERNATIVE?

The concept of the circular economy provides an interesting framework for how resources can be used more efficiently. The concept proposes an alternative to the linear production-consumption system. The core elements of the circular economy forms the conceptual framework for this PhD thesis. Yet, the concept will be presented in more detail and critically discussed in chapter 2. In present thesis, the concept of the circular economy is defined as:

“The Circular Economy describes an economic system that is based on business models which replace the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.”

(Kirschherr, Reike, & Hekkert, 2017: 225)

Even though the concept of the circular economy is often used to describe more efficient ways of managing material resources, I would like to stress that the aim is broader than that. The overall aim of the circular economy is to develop sustainable solutions, that *“meets the needs of current generations without compromising the ability of future generations to meet their own needs”* (WCED, 1987). This implies a balancing of environmental, social and economic considerations in an intergenerational perspective.

More concretely, the core principles of the Circular Economy are that resource use and waste per capita should be reduced. Rather than discarding products after use, the useful lifetime should be extended for as long as possible, for instance through measures like reuse, repair and maintenance. When a product is no longer useful, the components should be extracted and used for production of other types of things. Alternatively (and less optimal), recovery of the materials in the products to be used for production of new materials. As a final and least preferable solution, energy can be recovered from waste. This order of priority is subsequently referred to as *the waste hierarchy* (EU, 2008), which will also be elaborated in more detail in chapter 2.

Apart from presenting a vision of a more sustainable way of organizing the production-consumption system, practical strategies are suggested for how organizations and companies can re-organize their activities in more resource efficient ways. These strategies are moreover frequently presented to business actors as new, prosperous and at the same time more sustainable ways of doing business (EMF, 2013). The main enablers of the Circular Economy are thus changes in business models and consumers behaviors (Kirschherr et al., 2017).

1.4. HOW WASTE MANAGEMENT CAN PLAY AN ENABLING ROLE IN A TRANSITION TOWARDS A CIRCULAR ECONOMY

Within the ideal Circular Economy, waste does not exist. It has been designed out of products and systems. Consequently, there is no need for waste managers. So why apply the Circular Economy concept to a waste management company? The simple answer is that in reality, we are far from realizing a full circular economy. Consumption rates are increasing, and so is the rate natural resources are extracted and used (Hoorneweg & Bhada, 2012; WWF, 2014). Today a minority of products are designed for circulation, and the current structures of production-consumption-waste management have been established through a century long development. These production and consumption patterns are path-dependent, some might even say they are in a lock-in. Illustratively speaking, it is a larger supertanker to turn, and that requires massive changes within regulatory, institutional, cultural and normative settings to turn it towards a circular system.

Denmark has a well-established waste management system. The linear flow of resources go through production, consumption and then the waste management system, and from here, some resources are canalized back into the system. Thus, some circular flows are already established, such as recycling of paper, glass and metals. The current circular flows were not established by the original manufacturers of the products, nor by the consumers, but by the waste management sector (though pushed by regulatory factors). Consequently, the waste management sector has already played a role in the transition towards a circular economy.

For these reasons, it is relevant to investigate how municipal solid management companies like AVV can play an enhanced role in the transition to a more circular system. In scientific literature, the organizational rationales of municipal waste management companies have not received much attention (Corvellec, Bramryd, & Hultman, 2012). In the light of the call for a transition towards a circular economy, understanding the business logics of a municipal waste management company can form the basis for investigating which role they can play to support this transition and how circular business activities can be developed and implemented. Moreover, no single actor controls waste and thus no single actor alone holds the key to changing the linear production-consumption-waste management system. Waste generation and management takes place through a network of a complex variety of

actors. For this reason, the change towards a circular economy requires collaboration across a wide range of actors within the system (Bocken, Rana, & Short, 2015; Boons & Lüdeke-Freund, 2013) and a systems perspective on circular business strategies and innovation should be applied (Kirschherr et al., 2017).

This PhD project is a case study of how circular economy strategies and principles have inspired business model innovation within a municipal solid waste management company, AVV. Numerous studies and research have been made on how waste management can become more environmentally friendly, and how waste management can apply tools to optimize the waste treatment economically and environmentally, but only a few studies have applied business model thinking to a municipal solid waste management company (Corvellec et al., 2012). The scientific contribution of present study thus resides in its combination of the business model innovation concept, the concept of the Circular Economy and the empirical case of a waste management company. This combination provides new perspectives on sustainable waste management and presupposes that waste is considered to hold a value rather than simply being an environmental problem to handle. The challenge is how to create, deliver and capture value from something that has traditionally been a societal cost. The focus has so far been on minimizing the costs of collection and disposal of waste. But *“In a circular economy, the objective is to maximize value at each point in a product’s life”* (Stahel, 2016). For this reason, the question becomes central of what value is. Before exploring these conceptual building blocks in more details, I invite the reader to get to know better the case company Affaldsselskabet Vendsyssel Vest I/S.

1.5. THE MUNICIPAL SOLID WASTE MANAGEMENT COMPANY, AVV, AND HOW IT IS GOVERNED

Affaldsselskabet Vendsyssel Vest I/S (or simply AVV) constitutes the contextual setting in which the research has been conducted. Much of the research in present thesis is context dependent, and for this reason, a thorough understanding of the context is necessary. Therefore, I will outline in more detail the Danish waste management sector and present the company AVV as part of a wider complex socio-technical system of waste management. Moreover, I will describe the regulatory framework by which AVV is governed, as the regulatory framework is the baseline for what AVV can do in terms of circular economy.

1.5.1. WASTE MANAGEMENT AS SOCIOTECHNICAL SYSTEMS

Waste management is part of the larger system of production and consumption. Waste management is a complex socio-technical system as it involves both technologies, infrastructure, different stakeholders and governance structures. The interrelatedness between human behavior and the technologies affects the effectiveness and reliability by which the system can achieve its goals (de Bruijn &

Herder, 2009), i.e. an optimal (economically efficient and environmentally sound) waste management. For instance, the sorting that takes place in the households determine what treatment options are possible and the other way around.

Governance structures places the responsibility for household waste on the public waste managers and the industry waste on private waste management actors, and this determines what is possible for a municipal waste management company like AVV to do.

The socio-technical system of waste management is comprised by a variety of sub-systems. These include systems at different levels such as the waste sorting that takes place within the households; the systems for collecting waste by both private and public actors; the systems for managing and treating specific waste types in combinations of recycling, anaerobic digestion, incineration, landfilling; and recovery of materials and energy from waste (Kreith & Tchobanoglous, 2002). Each component of the waste management system is interconnected to the other components in a complex net. Figure 1.1 shows the different functions, elements, stakeholders and structures in an integrated waste management system. AVV does not operate within all parts of the waste management system, but mainly within the sub-systems of designing and managing the collection, transport, and to some extent treatment and disposal, i.e. incineration and disposal. They do not recover materials from waste.

Waste management research concerns technological aspects, such as tools and models for optimization of the economic and/or environmental operation of the system (Juul, Münster, Ravn, & Süderman, 2013). The behavioral aspects of waste management have also received increased attention in research (such as Barr et al., 2013).), but the linkages between are less explored.

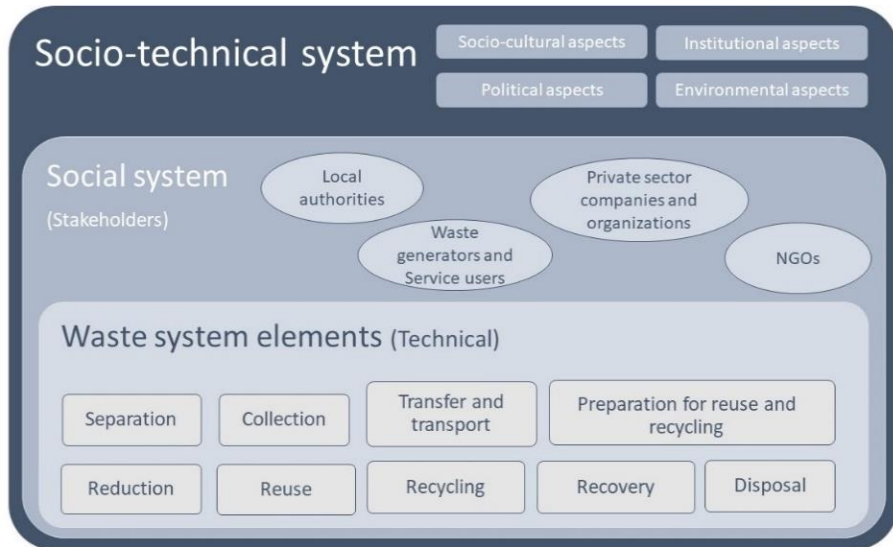


Figure 1.1 Waste management takes place within a system of technical solutions, interests and conducts of a variety of stakeholders, and within a particular cultural, political and institutional environment. The materials flow through the different stages of the waste management system (based on (Kreith & Tchobanoglous, 2002; Ordonez Pizarro, 2016). AVV operates within some parts of the system, but interacts with stakeholders in the social part of the system and are subjected to financial, environmental, political, and cultural aspects.

In Denmark, waste management is partly conducted by private companies and partly by public authorities. Collection of waste at the households are most often contracted out from municipalities to transport firms (Grønnegaard Christensen, 2001), whereas the operation of recycling centers are usually a municipal task or the task of a public interest company like AVV. The processing of waste is divided between municipal and private actors; the majority of incineration plants are municipally/publicly owned, whereas the majority of recycling activities are conducted by private companies (Dam, 2015). The landscape of recycling companies has evolved from consisting of many, smaller, local businesses to now comprising mainly large, specialized, often multi-national companies covering large parts of the international market for waste processing (ibid).

During the last three decades, there has been political debates about liberalization of publicly owned municipal waste management companies (Grønnegaard Christensen, 2001). Concerns have been raised about transparency, efficiency and competitiveness of this type of monopolistic companies (ibid). This has created tensions and uncertainties in the sector (interview with manager).

The complexity of the waste management system is increasing as products and thus waste becomes more complex consisting of a variety of materials. Moreover,

technological development within recycling of waste materials broadens the network of actors within the system. Management of municipal waste is often considered to be particularly challenging due to the heterogenic character of this kind of waste (Hoornweg & Bhada, 2012).

1.5.2. AVVS ORGANISATION, PURPOSE AND FUNCTIONS IN THE WASTE MANAGEMENT SYSTEM

AVV was formed in 1988. AVVs overall purpose is to manage the waste from its two owner municipalities, Hjørring and Brønderslev, and specifically the waste from app. 100,000 citizens, which equals 46,000 households. As such, AVV represents a typical Danish municipal waste management company. The purpose of its existence includes planning and managing waste collection systems, establishing and operating recycling centers, incineration plants, sorting facilities and disposals, and marketing waste products and materials. This PhD project is delimited to focus only on household waste.

1.5.2.1 AVVs organisational structure

A politically appointed board makes the overall strategic decisions about the operations and development of AVV. The board is elected for a four-year period.

AVV is organized into seven departments. This is shown in figure 1.2. I was employed in the Innovation department, and most of the research in present thesis are contextually situated in the innovation department, the recycling centers, the reuse shop and the workshop activities that developed from the reuse shop department. The departments of incineration, transport and logistics, and hazardous waste play a minor role in the project. In total, there are 115 employees. The innovation department was formed in 2012, and before that it was called the technical department. The change of name was a symbolic act to emphasize that innovation was endeavored.

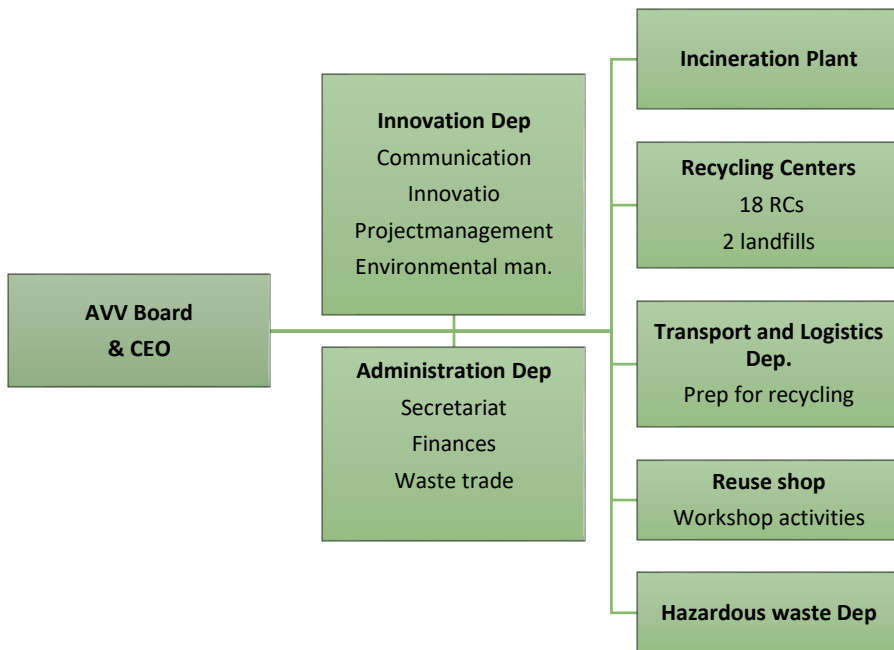


Figure 1.2 There are seven departments in AVV. During the PhD project, I was located in the Innovation Department

1.5.2.2 Values, Visions and Strategy

In 2011, a new CEO entered office, and he initiated a process of developing a new vision, strategy and core values for AVV. The core values are:

- Think: the Environment first
- Show Respect
- Take Responsibility
- Be at the Forefront

The values are formulated as encouragements to act. The first value (Think: the environment first) encourages employees to consider environmental impacts of every project or solution. However, this value is formulated with a “Think:” before “the environment first”, and this is a consequence of the fact that some environmentally superior solutions are costly, and sometimes too costly to be pursued. “Show Respect” is an encouragement to employees to be respectful to each other and to external stakeholders. “Take responsibility” is also aimed at employees but it is also aimed more broadly for AVV to take responsibility in a wider sense, such as taking responsibility for and engaging in environmental and societal

challenges. “Be at the Forefront” shows that AVV aims at being innovative, proactive, efficient, and wants to be known for it too.

More specifically, these values transpose into strategic objectives and decisions such as

- engaging the cooperation agreement with Aalborg University;
- implementation of an environmental management system (EMAS);
- aim to development of new green business models;
- aim to increase collection for recycling to 80 %.

The level of specificity varies among the strategic objects.

1.5.2.3 Main business activities and operations in AVV

AVVs tasks are defined and planned in dialogue with the owners, i.e. the municipal waste authorities. AVVs business activities and operations can be grouped into four main types of activities: collection activities; treatment activities; marketing of waste products and materials; and communication activities. These are shown in figure 1.3. The activities are mutually dependent, and they will each be elaborated in the following.

Collection	Treatment	Marketing	Communication
• Recycling centers • Bobbles • Kerbside collection • Daily discard, weekly collection	• Preparing for reuse and recycling (repair, sorting, pressing and baling) • Incineration with energy recovery • Disposal/landfill	• Reuse shop • Web auction with second hand products for private consumers • Sales of recyclable waste for private business actors	• Guided tours around the waste management facilities • Lectures • Awareness projects • Participation at sustainability festivals • Car boot sales

Figure 1.3 AVVs main business activities can be divided into collection, treatment, marketing and communication.

Collection activities

AVV collects household waste in the two municipalities in four different ways: weekly daily discard collection at the household; curbside bulky waste collection ordering service; bobbles of glass and paper; recycling centers. These four collection schemes are shown in table 1.1, which also shows the amount of waste collected through each scheme.

Table 1.1 Four different ways that citizens can discard their waste. Household waste is collected in each scheme in 2016 (AVV, 2017 and AVVs waste database)

Collection scheme	Tons of waste collected annually
Recycling centers	60,530
Daily discard	23,373
Curbside collection of bulky waste	7,420
Bobbles	2,797
Total	94,120

Firstly, AVV organizes 18 **recycling centers** distributed in the area. Recycling centers are areas equipped with containers for app. 40 different types of waste. Citizens drive into the site in car and often with a trailer with their waste (all other kinds of waste than daily discard) and are supposed to sort it into the designated containers. The sites are manned with employees who are to keep the site in order and guide the citizens to sort correctly. Figure 1.4 shows a map of one of AVVs recycling centers. On the map, the different waste types are labelled on the containers. It is prohibited to bring daily discard to the recycling centers.

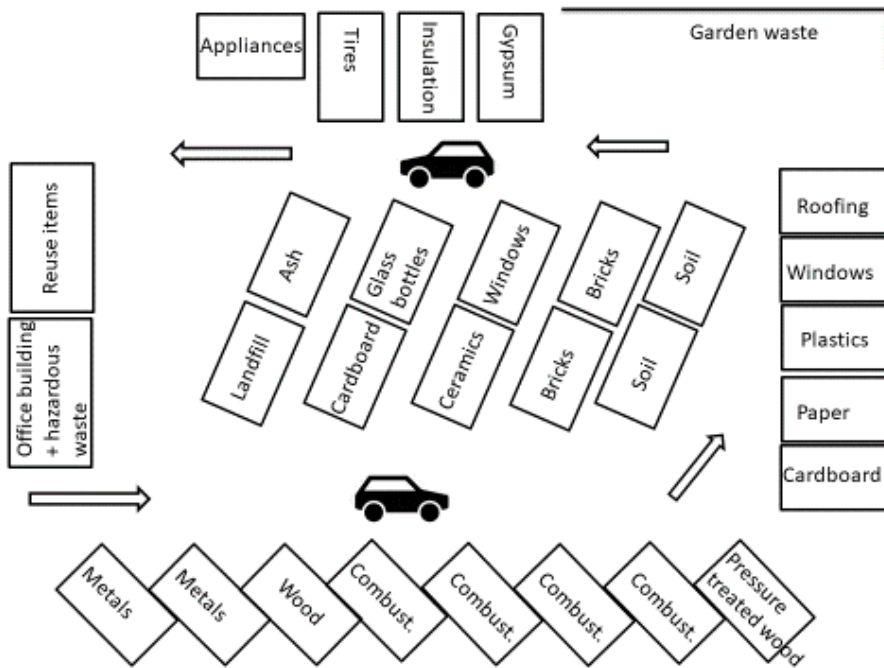


Figure 1.4 AVVs recycling centers are equipped with containers for different types of waste. Citizens drive in and sort their waste into the designated containers.

The **daily discard** gets collected at the households once a week, but this particular task has so far not been AVVs. The municipalities have organized this collection, but from 2018, AVV will take responsibility for this. At that time, enhanced source separation of the waste is going to take place in the households. This implies that the collection task will change from comprising the collection of one fraction (discard for incineration) to 3-4 fractions (metals/plastic; paper; organic waste; and daily discard).

Citizens also have the opportunity to get their bulky waste collected through a **curbside collection scheme** if they do not have the opportunity to bring it themselves to the recycling centers.

Some common recyclable fractions are collected in the so called “**bobbles**” (see figure 1.5). The bobbles are dispersed at 250 sites in the area, often near schools, housings and shops. Here the citizens can bring their glass and paper waste.



Figure 1.5 The so-called "Bobbles" for collection of recyclable glass and paper (avv.dk)

Treatment of waste

When the waste has been collected, AVV has the responsibility to treat it or to prepare it for treatment. Waste treatment within the municipal waste management is regulated by the Danish executive order on waste management (Miljøministeriet, 2012). This executive order shows how waste treatment solutions should be prioritized in a ranked order:

1. Preparation for reuse
2. Recycling
3. Other recovery, including incineration
4. Disposal

(Affaldsbekendtgørelsen §12, 2012)

In AVV, 2 % of the collected household waste is prepared for reuse and sold as second-hand items in AVV's reuse shop. The waste that is prepared for reuse stems from the recycling centers, where citizens can actively choose to donate used items for reuse.

Fifty-two percent (52 %) of the waste is recycled. Most of the recycled waste stems from the collection at the recycling centers. Some of this waste is of such a quality that it can be sold directly on the recycling market, while other types need to be sorted to increase the purity before it can be recycled. These preparation activities are a prerequisite for recycling. So far, the majority of the daily discard collected at the households (minus glass and paper, which are collected in the bobbles) has been incinerated, but from 2018, a new collection scheme will be introduced. In this scheme, citizens are to sort their daily discard into four types, of which the three are recyclable. Hence, from 2018 the percentage of waste treated for recycling will

increase. AVV does not operate any recycling facilities themselves, but prepares waste for others to process and transform the waste into secondary resources.

Forty-three percent (43 %) of the waste collected today is incinerated with energy recovery. The incineration plant, however, burns much more waste than the collected household waste. Waste for incineration is bought and sold on the market, and the operations of the incineration plants depend on an optimal combination of waste amounts, types, its calorific value, and legal requirements to the waste.

Three percent of the waste is disposed in landfills. The majority of landfill waste are toxic waste, e.g. waste types containing asbestos, mercury and other hazardous substances. These cannot or should for environmental reasons not be recycled.

Table 1.2 shows how the collected household waste in 2016 is distributed among the four different treatment solutions (based on AVV (2017) and internal AVV data)

Treatment type	Percentage of waste (%)
Preparation for reuse (and sales in reuse shop)	2
Recycling	52
Incineration	43
Disposal (landfill)	3

Marketing of waste

Recyclable waste, such as paper, cardboard, plastics, metal, glass, gypsum, tires etc. can be sold as a commodity when the purity of the waste fractions are high enough. In the marketing activities, considerations are made to prices, the environmental profile of the buying companies (environmental certification schemes), and the degree to which the materials are actually recycled (AVV, 2017). This is in practice, however, very difficult to get insight into. Moreover, efforts are made to cooperate with local actors and sell the waste materials locally (ibid). Many waste types, however, require technological treatment facilities to be converted into useful secondary raw material. Technologies that are not present in North Jutland or even Denmark, and some waste types are thus sold either directly to global actors or via waste brokers. In most cases, AVV loses track of what happens to the waste materials in one or two steps down the value chain. Hence, full accounting for a closing of material loops does not happen.

Reusable waste is sold in the reuse shop. The reuse shop is more thoroughly described in chapter 4.

Communication activities and prevention

In addition to the management activities, AVV also offers different communication activities. These communication activities encompass guided tours around the plants and facilities; lectures for citizens, students and actors in the sector; car boot sales; participation at sustainability oriented events and festivals; waste-related activities for school children, elderly people, companies, citizen associations etc. The aim of these activities is to inform citizens about waste and resources and to teach and enable them to sort their own household waste better and how to take waste preventive measures in their daily lives. In total, 150 communication events took place in 2016 (AVV, 2017). These communication activities are prioritized due to the impact citizens' waste related behaviors have on the functioning of the subsequent parts of the waste management system, cf. waste management being not just a matter of technical capacity but also closely related to social and behavioral aspects of the stakeholders.

These four pillars of waste management (collection, treatment, marketing and communication) are interdependent and inseparable. The way the waste is collected determines which treatment options should be and are available. Moreover, the purity of waste fractions, i.e. how well the waste is sorted, is determining the prices that the recyclable waste can be sold for. This means that the citizens' sorting efforts are of importance. Oppositely, there is no reason to endeavor an improved sorting of waste if the needed treatment technologies are not available. The citizens' waste related practices affect the waste generation and sorting, and this again necessitates the communication activities.

1.5.3. REGULATORY FRAMEWORK GOVERNING WASTE MANAGEMENT IN DENMARK

Of similar importance to understand the contextual setting of present study, is the regulatory framework governing AVV.

The regulatory framework for waste management in Denmark consists of a mix of mainly EU, national and local policies and regulations. There are also other supranational policies, which have affected waste regulation, for instance the Basel convention and OECD. Some principles, such as the principle of the polluter pays comes from these. However, I delimit this section from going into detail with these. In the following, I present the regulation in this consecutive order.

1.5.3.1 EU policy framework

At EU level, the Roadmap for a resource efficient Europe published in 2011 (EC, 2011) set out visions for 2020. These visions include

- Waste generation per capita should be in decline
- Recycling and reuse should be considered economically attractive options and more materials should be recycled
- Energy recovery should used only be for non-recyclable materials and landfilling and virtually be limited

Subsequent to this ‘Roadmap for a resource efficient Europe’ the first outline of a circular economy vision for Europe was published in 2014. It was called “Towards a circular economy: a zero waste programme for Europe” (EC, 2014). Due to the entrance into office of a new commission with a new commission president, this legislative proposal was withdrawn, and the Commission adopted a new package in December 2015, “The circular economy action plan”. This package consists of number of legislative proposals to support the transition to a circular economy and achieve a more sustainable consumption and production. It includes proposals for different steps in the value chain, including among other

- strengthening of guarantees for consumers to contribute to durability and reparability of products
- two-year guarantee for second-hand products
- eco-design requirements
- initiatives to support food waste prevention
- integration of circular economy aspects in green public procurement

(European Commission, 2017b)

EU Legislation

The more specific legislation for waste is currently being negotiated. The current Waste Framework Directive from 2008 obliges member states to increase collection for recycling of household waste to 50 %. In the proposal for the amendment of the directive, this is suggested to be increased to 65 % by 2030 (EU, 2015). Moreover, it was initially suggested to introduce new measures to promote prevention, particularly of food waste, and re-use (ibid). However, minutes from the latest negotiations indicate that there will be no specific separate quantitative targets for this.

The legislation for waste includes directives for some specific waste types. There is a separate directive for packaging waste and electrical and electronic waste (WEEE), and a landfill directive. The WEEE directive plays a role in chapter 6 of the present thesis, and therefore it is more thoroughly described in that chapter.

The waste framework directive from 2008 obliges the member states to develop national waste prevention plans. This requirement is more thoroughly described and dealt with in chapter 5 about waste prevention.

1.5.3.2 Danish policy framework

In Denmark, the Danish Environmental Protection Act clearly specifies that prevention is to be prioritized over treatment. Moreover, it defines the roles and responsibilities and is the Danish transposition of the European Waste Framework Directive. Central in this is the non-profit principles of the municipal waste management. Moreover, it specifies that municipalities are to collect and manage the household waste, whereas the industrial waste is to be managed by private sector actors. This is referred to as a liberalization of the waste sector.

The Danish Resource Strategy: “Denmark without waste”

The Danish Government’s strategy for waste management is called “Denmark without waste – reuse more, incinerate less”. It is framed as a “resource strategy” rather than a waste management strategy. The strategy is clearly inspired by circular economy rhetoric. In the foreword, it emphasizes how incineration as the dominant waste management solution so far has caused a loss of materials and resources that could have been used. It moreover emphasizes the need to divert waste management towards increased recycling.

The resource plan more specifically obliges the Danish municipalities to collect 50 % of the household waste for recycling by 2022. However, this requirement only applies to the so-called seven focus fractions, which are paper, cardboard, glass, metals, plastic, wood and organic waste.

Along with the adoption of this plan, the government established a funding program to assist the Danish municipalities in developing new solutions to achieve these targets. Thereby supporting the transition.

As part of the resource strategy, is also a national waste prevention plan. This plan does not set any specific quantitative objectives for waste prevention, and it did not oblige any specific actors as responsible for waste prevention initiatives. Most notably, the waste management sector was not appointed any role in this. In the hearing phase of the strategy for prevention, AVV and other actors made clear that in their opinion municipalities should be appointed a more active role in waste prevention. The reply from the Environmental Protection Agency was that “*the citizen waste fees can only be used for recycling, incineration and disposal at landfills*” (Miljøstyrelsen, 2015), thus not on prevention and reuse.

The Danish waste executive order (Miljøministeriet, 2012) consists of the most important rules about the municipalities' and private sector collection and management of waste. It specifies the waste hierarchy to be used in the municipal waste management, and unlike the Environmental Protection Act it does not place prevention as a top priority. This means that the municipalities are not obliged to take waste preventive measures. In fact, they are not allowed to spend citizen fees on prevention activities. They are simply only to manage the waste once it has been generated. This may be why the municipal waste authorities were not appointed to take part of the waste prevention initiatives.

In 2015, the Confederation of the Danish Industry filed a complaint to the appeals board about the municipalities operation of reuse shops. They claimed that these reuse shop distorted the competition on the second-hand market because they were operated by the municipalities (Dansk Industri, 2015). In 2017, the Appeals board decided in favor of the municipalities, that it is the right of the municipalities to prioritize preparation for reuse, including the sales of used products. However, this decision did not apply to WEEE, because it is covered by the producer responsibility scheme (is analyzed in chapter 6).

1.6. PURPOSE AND RESEARCH QUESTIONS

In this thesis, I present my investigation of how the principles of the circular economy can be applied in the local context of a Danish municipal waste management company. The research has been carried out in the context of the municipal waste management company, AVV in Northern Jutland.

A societal transition to a circular economy requires systemic changes, and changes in business models is one of the enablers of the circular economy (Kirschherr, Reike, & Hekkert, 2017; MacArthur Foundation, 2015). On a similar note, Schot & Geels, (2008) propose that societal changes towards sustainability can be enabled through innovations and practical experiences at niche level, i.e. *“protected spaces that allow nurturing and experimentation with the co-evolution of technology, user practices and regulatory structures”* (ibid: 538). Learnings from such niche projects can subsequently be used as building blocks for broader societal changes. Niche experiments are proposed to focus on concepts, visions and guiding principles rather than technologies, and to begin with a focus on the social aspects of the socio-technical system (Hegger, van Vliet, & van Vliet, 2007). The circular economy is a concept that provides a set of guiding principles, but how these can be applied in practice in the waste sector is the theme of inquiry in this thesis investigated through practical experiments.

The transition to a circular economy requires the engagement of all actors in a value chain, including companies in the waste sector. The waste sector already plays an important role in enabling the circulation of material resources by organizing the

collection of waste and the recycling and recovery. However, the circular economy concept provides a new discursive framework for understanding waste resources (Blomsma & Brennan, 2017), which can inspire waste managers to develop new business models.

More specifically, the waste hierarchy principles of the circular economy does not seem to be fully prevailing in today's waste regulation, nor in the practical management of waste, as only recycling and recover strategies are pursued. Reuse and prevention, though principally superior, are not common practices in the waste management sector. Similarly, within the societal, political and scientific debates, prevention and reuse of waste have so far played a secondary role compared to closing material loops through recycling. For this reason, it is relevant to develop new solutions that reduce the amounts of waste generated and extends the life of products that are discarded as waste.

In addition to this, the circular economy concept emphasizes value creation. Within waste management, emphasis has so far mainly been on efficiency and cost-minimization. The notion of value creation from waste is a new perspective on waste management, which requires other local competences and practices in the waste management sector. For this reason, it is relevant to investigate and clarify how the circular economy concept can become concretized at a local practical level.

The overall research question is as follows:

How can innovative, local, circular economy solutions and business models for waste reduction and reuse be developed and established in a municipal solid management company (AVV) in co-existence with traditional waste management solutions?

1.6.1. AIMS

The research project is embedded in a company as an industrial PhD project, thus financed partly by AVV and partly by the Innovation Fund Denmark. Being an industrial PhD project, the purpose of this PhD project is two-fold with both scientific as well as commercial aims (Innovation Fund Denmark, 2017).

The projects overall purpose is to investigate how AVV can initiate and/or engage in local innovative solutions for waste prevention and reuse through an establishment of circular business models. This overall purpose aims at contributing both to the academic knowledge creation, to the development in the local community and to commercial/business development opportunities in the following ways:

1. To contribute to understanding of how local systems and business models for waste prevention, reuse and refurbishment can be developed within the

- context a municipal waste management company and be integrated into the existing waste management system (Scientific contribution)
2. Investigate how (if) new circular economy solutions and business models for waste prevention, reuse and refurbishment can create value for a municipal waste management company and its local stakeholders (Scientific and commercial)
 3. To contribute to AVVs strategic competences and adaptability to a circular economy, by upgrading knowledge and competences within these fields central to the future waste management and resource regulation (Commercial/business development)

Even though, I make a division of scientific and commercial/business development oriented aims, they are in practice inseparable and interdependent. The following old citation of Diderot points towards the need of developing practice in combination with theory, and vice versa:

“Every art has its own speculation and its own practice: speculation is nothing but useless knowledge about the rules of the art, and its practice consists of its usual and unreflected use of these same rules. It is difficult, if not impossible, to develop practice without speculation and vice versa to have a good grip on speculation without practice. In every art, there is a diversity of circumstances, which can only be learnt through usage. It is up to practice to suggest challenges and present phenomena, while it rests on speculation to explain phenomena and dissolve the challenges”. (Diderot, 1751: 266)

In other words, the theories and principles of the circular economy, even though they seem practically applicable, are to be implemented in the reality of a waste management company under the diversity of circumstances that exist here. It is with such practical experimentation with circular economy concepts in the real-life context of waste management, that useful knowledge can be developed.

The main research question and the research aims will be analyzed through four sub-questions:

1. *How can reduction and waste prevention be understood, conceptualized and applied within a municipal waste management company?*
2. *What are the potentials and barriers to develop preparation-for-reuse activities within AVV as a part of the larger socio-technical system of waste management?*
3. *How are the value creation potentials from an improved separate collection and preparation for reuse and recycling of waste from recycling*

centers? How does this look from the perspective of the municipal waste management company and the local society?

4. *How can internal work and management practices in a municipal waste management company support or hinder the development of more sustainable and circular waste management solutions?*

The first question focuses on conceptualizing waste prevention on the basis of state-of-the-art investigation, i.e. a literature study. Understanding what waste prevention can imply and what it requires is a prerequisite for the waste management sector to develop appropriate waste prevention solutions. This is presented in Article A “*Understanding the role of waste prevention in local waste management – a literature review*” (Zacho & Mosgaard, 2016).

The second sub-question investigates the possibilities for preparing waste for reuse by mapping the interests and demands of all the major stakeholders within the sociotechnical system of waste management. This sub-study is investigated through a) a case study of one particular waste type, WEEE (Waste Electrical and Electronic Equipment), which is governed by a regulatory framework aiming at incentivizing producer responsibility (Article B: “*Socio-technical perspectives on the Danish WEEE management system – Investigating constraints and possibilities for integrating prepare-for-reuse as a management solution*”), and b) through an ethnographic case study of the experimental process within AVV to develop new products from waste.

The third sub-question takes point of departure in one of the key concepts of the circular economy, i.e. that value can be created and extracted from waste. Based on practical experiments and development processes in AVV, the value creation potentials are explored in Article C “*Local value capture from increased preparation for reuse and recycling*”, and in a following case study narrative.

The fourth sub-question zooms in on the internal work practices in AVV in order to investigate if the management’s strategic focus on circular economy is propagated among the employees in the company, and whether the daily work practices supports a transition towards a circular economy. This is presented in Article D “*Working practices at recycling centers and their influence on the rates of reuse and recycling*”.

1.6.2. RELATIONSHIP BETWEEN SUB-QUESTIONS AND ARTICLES

The research sub-questions have been investigated and has resulted in four research articles. The research articles are included in present thesis as parts of chapters. These articles have aimed to lift the research out of the context of AVV to increase the broader scientific value. Yet, each sub-study has also contributed to developing

competences and knowledge in AVV and have inspired the initiation of other projects in the firm. In order to account for how the PhD project has contributed to the development in AVV, some of the chapters include a case study narrative of this in addition to the research articles. These case study narratives also contribute to answering the main research question by elucidating key processual elements that have enabled the creation (or hindrance) of new circular economy solutions and business models in AVV, thus increasing our understanding of how the circular economy concept can be concretized at local level. In this way, the interdependence between the academic and commercial aims should be understood.

The introduction to the thesis comprises a theoretical chapter in which the conceptual framework for the project is developed and outlined. Chapter 3 presents the methodology and research methods. After this, the results are presented in the chapters 4, 5, 6, 7 and 8. These chapters partly consist of four research articles and partly case study narratives. Figure 1.6 presents a graphic illustration of how the research articles are linked to the case study, and thus how the sub-questions relate to the overall research question. In chapter 9, the results are discussed, ending with a conclusion in chapter 10.

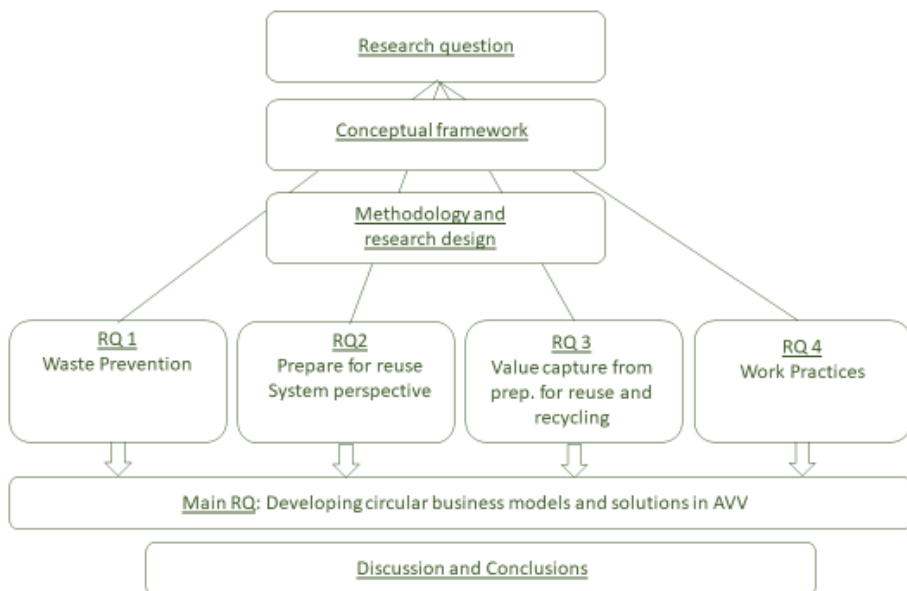


Figure 1.6 Research design and the connection between the sub-questions and the overall research question

CHAPTER 2. CONCEPTUAL FRAMEWORK

In this chapter, I will construct my conceptual framework related to the concept *circular economy*. This concept is a new framing of waste and resource productivity (Blomsma & Brennan, 2017), yet building on previous concepts and thoughts. Consensus has not yet been established among academics and practitioners about its conceptualizations. For example, Kirschherr et al. (2017) recently identified at least 114 different definitions of the concept during their review. Given the variety of understandings of the concept and its principles and aims, there is a need to specify how the concept is understood and conceptualized in this project. I will not make a full account of the concept and its founding ideas, but rather pull to the forefront the elements and principles that I apply in my research. Moreover, I will critically discuss certain elements in more detail with the aim to contribute to the further formation of the concept. The function of this chapter thus is to inform the rest of my design, i.e. guide the research questions and the analyses.

Within the waste sector, the circular economy concepts are gaining ground. For instance, the concept is becoming a central part of European waste regulation, exemplified by the publication of The Circular Economy Package (European Commission, 2017b), and circular economy appears frequently at conferences, meetings and documents. However, throughout my own personal encounters with people in the waste sector, I have frequently met uncertainty and curiosity about what the “circular economy” actually means. As within academia, there does not yet seem to be a common understanding of how the waste sector can apply the circular economy concept in strategies and planning.

Another concept that recurs in contemporary waste policies is the waste hierarchy. The waste hierarchy ranks different waste management options in a prioritized order based on their environmental impact (I. Williams, 2015). Where the concept of the circular economy is still emergent, the principles of the waste hierarchy is more institutionalized and incorporated in the common understandings and social narratives in the waste sector (Seadon, 2006). The waste hierarchy has played a role in waste policies since its emergence in 1975. It is frequently used as a guiding principle in municipal waste planning (at least intentionally), and it is described in the Danish waste decree (Miljøministeriet, 2012) (Affaldsbekendtgørelsen).

For this reason, this chapter begins with a presentation of the waste hierarchy. By describing the waste hierarchy, the definitions of the generic waste management solutions will also be examined. These waste management solutions and their ranking are also encompassed by the concept of the circular economy. The circular economy is an umbrella concept encompassing the waste hierarchy but also other

additional principles. These additional features provide something new to the waste sector, and therefore I will elaborate and discuss the circular economy in the light of waste management.

2.1. THE WASTE HIERARCHY

The waste hierarchy was first introduced in European waste legislation in 1975 (*Council Directive 75/442/EEC*, 1975). At the time, it was optional for the member states whether they would implement it or not, and thus in practice it had little effect. Moreover, the first version did not include prevention, and reuse and recycling were combined as one treatment option. During the following years, the waste hierarchy was refined and formalized into an ordered system of preferred waste management solutions (I. Williams, 2015). Finally, in 2008, a new version of the waste hierarchy was announced along with a revision of the Waste Framework Directive 2008/98/EC (EU, 2008). At this point, it became mandatory for the EU member states to implement it into national legislation. Bartl (2014) describes the implementation of this directive as a turning point in European waste policy: where waste had previously been seen as an environmental threat to be treated, the entire supply chain of a product is now placed in the forefront of interest. Other versions of the WH also exist, but I have chosen to apply the waste hierarchy in the form from the European Waste Framework Directive 2008/98/EC, because this is the regulatory framework that AVV is subjected to. Moreover, this version is developed to be a tool for waste managers to use, opposite other more generic versions not addressing specific actors. Figure 2.1 depicts the European waste hierarchy along with the definition of each step. Subsequently, I elaborate and discuss the steps and their definitions further.

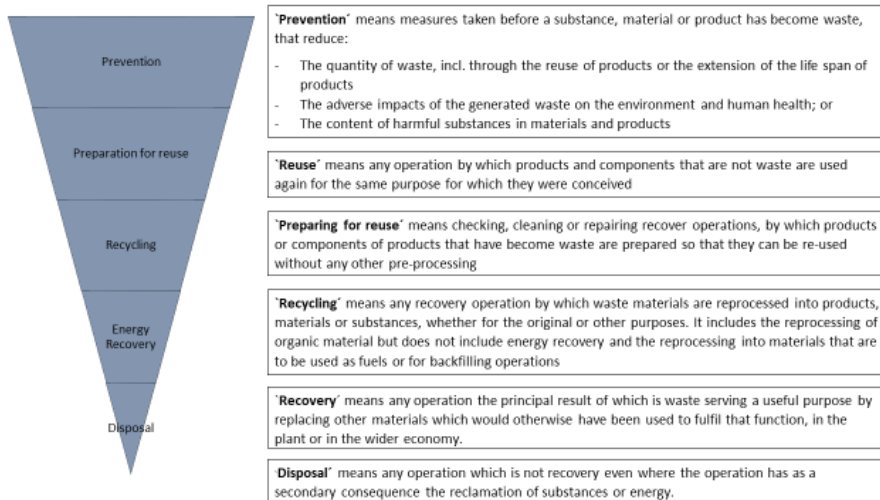


Figure 2.1. The European waste hierarchy ranks different waste management solutions in a prioritized order (EU, 2008)

2.1.1. LIFE CYCLE THINKING AS BASIS FOR THE PRIORITY ORDER

The waste hierarchy (figure 2.1) ranks different waste management options in a prioritized order according to their environmental impacts. The order of options is based on life cycle thinking, which takes into account the environmental burdens of each option throughout the value chain. Hence, waste prevention is the first prioritized option (top of the hierarchy) since it not only prevents the treatment of waste but also have upstream reducing effects on the production, distribution and consumption of new products. The definition of prevention (see figure 2.1) includes both qualitative and quantitative aspects, i.e. measures to reduce and minimize the amounts of waste, but also measures that decrease the hazardousness of waste. Thus, preventive measures can be taken by several different actors in the value chain: Some can only be taken by designers and producers - such as the decision to avoid hazardous substances and design for longevity. Others can only be taken by the consumer - such as deciding to prolong the useful lifetime rather than replacing products with new ones. Which preventive measures that can be taken by waste managers is more unclear, hence dealt with in chapter 5 (Article A: The role of waste prevention in local waste management: A literature review). Preventive measures cover both *avoidance* (such as buying fewer items, with less packaging) and *reduction* (such as keeping products in use for longer) (DEFRA, 2011).

The second best option is reuse. Within the Waste Framework Directive 2008/98/EC, reusing items is by definition a part of prevention (see definition in figure 2.1). This is due to life cycle thinking, where reuse entails a prolongation of a product's lifetime thus preventing production, acquisition and use of new stuff and

postponing other waste treatment solutions further down the hierarchy. Within the Waste Framework Directive's version of the waste hierarchy, reuse is not an individual step but an inherent part of the first step, i.e. prevention. In practice, it is challenging to assess whether reuse actually is a waste preventing measure (Cooper & Gutowski, 2017). For instance, the reuse of a t-shirt does not necessarily displace the acquisition of a new t-shirt. Similarly, when a child inherits the parents old TV because the parents acquire a new one, this reuse actually might entail increased environmental impacts as the household now have two TVs consuming power (Bulkeley & Gregson, 2009). As a rule of thumb, reuse must displace the acquisition of other stuff in order to entail environmental benefits.

The second step in the waste hierarchy is "preparing for reuse". This concept seems to cause some confusion. Why is it not just called "reuse"? This is because waste managers cannot *reuse* anything. A waste manager (or other actors) can *prepare* waste items to be reused, but it is ultimately consumers who (re)use the items. "Prepare for reuse" is a waste management option (unlike reuse which is an action conducted by consumers). Preparing for reuse can include processes such as inspection, cleaning, testing, repairing or simply just putting items on a shelf making it ready for sales or give away, thus enabling used products to be used again for the original or a different purpose and to be marketed into the same or a different market.

The third step in the waste hierarchy is recycling. In recycling processes, the materials within the waste are reprocessed into new materials and products (see definition in figure 2.1). As with "reuse", "recycling" may not necessarily entail positive environmental impacts. Environmental impacts related to the collection, transport and recycling processes should not exceed the impacts of other management options. Moreover, in order for recycling to have a reducing effect on raw material extraction, it has to actually displace the use of raw materials. *"... in the long run, recycling reduces waste generation only if it reduces primary material production; otherwise , it merely delays it"* (Geyer, Kuczenski, Zink, & Henderson, 2016). In practice, recycling processes can change the inherent properties of the materials so that the recycled material cannot compete in quality and/or price with raw material (Zink & Geyer, 2017). For this reason, Geyer et al., (2016) recommends that when planning recycling four questions should be considered:

1. *What and how much primary resource does a recycling activity replace?*
2. *Which uses of a recycled material have the highest impact reduction potential?*
3. *What is the best level of reprocessing? Does further increasing the value of the secondary resource increase its impact reduction potential?*
4. *How can the triad of collection, recycling, and displacement rates be increased in a way that increases impact reduction potential?*

(Geyer, Kuczenski, Zink, & Henderson, 2016)

Another point emphasized by Zink & Geyer (2017) and Gregson, Watkins, & Calestani (2013) is that recycling consists of a line of activities taking place globally often with a multitude of actors involved. They point out that market forces play a more vital role for whether recycling actually displace the use of raw materials than technical or engineering relationships. *“increased recycling may fail to displace virgin material of the same kind if there is no market willing or able to absorb the increased material”* (Zink & Geyer, 2017; 2). Recycled materials can also displace other types of materials, including other types of recycled material, or displace nothing at all (Ekvall & Weidema, 2004), with the latter leading to an increased total consumption.

The fourth step in the waste hierarchy encompasses other types of recovery. This is typically energy recovery from waste incineration. Waste incineration with energy recovery has been the dominant waste management solution in Denmark and other northern European countries for decades. Even though, anaerobic digestion of organic waste is a type of energy recovery, anaerobic digestion where the digestate is recycled as fertilizer is in European waste legislation considered to be within the recycling step of the waste hierarchy (European Commission, 2017a)(European Commission, 2017b).

The least preferred option is disposal. Disposal encompasses landfilling, but also incineration with limited energy recovery. In some EU member states, landfilling comprise more than 90 % of the waste management. Particularly Southern and Eastern European countries rely heavily on landfilling (Eurostat, 2017).

In some instances, there may for environmental reasons be deviations from the preferred order of the waste hierarchy. For instance, plastics containing hazardous substances may well better be incinerated than recycled in order not to spread the hazardous substances further. The waste framework Directive (art. 4, 2) and the Danish waste executive order (§ 12, 2-3) leaves room for such deviations from the priority order when the environmental consequences of managing the waste further down the waste hierarchy are lower (EU, 2008; Miljøministeriet, 2012). This shows that the waste hierarchy is developed for environmental reasons rather than resource conserving reasons, at the most resource conserving choices may not always be the most environmentally friendly.

The waste framework Directive obliges all member states to incorporate the waste hierarchy into their national plans. Moreover, the Directive sets a number of targets:

- By 2011, member states must have developed a national waste prevention plan (art. 9)
- By 2020, at least 50 % of household waste, such as paper, cardboard, metal, plastic, glass, wood and organic waste, must be collected for recycling or prepared for reuse (art. 11)

(EU, 2008)

Some authors criticize the waste hierarchy for being inadequate in reducing consumption of natural resources and impacts on the environment (van Ewijk & Stegemann, 2014). Given the fact that the 50 % recycling target in practice applies to “waste collected for recycling” and does not take into account the rate with which recycling actually replace virgin materials (cf. the above mentioned considerations on recycling), there are reasons to question the adequacy of the waste hierarchy. Similarly, Seadon (2006) points out that the upper levels of the waste hierarchy are difficult to implement because waste managers have no control of production and consumption decisions. Gharfalkar et al., (2015) criticize the waste hierarchy for lacking clarity on particularly prevention, reuse and preparation for reuse, and for not having included “reuse”, “repair” and “recovery” as individual steps in the hierarchy. In their opinion, these flaws reduce the concepts ability to bring about the best solution. This latter critique fails to notice that the waste hierarchy as it is presented in the Waste Framework Directive applies to waste managers and planners as a tool to guide waste management options. It was not intentionally developed as a resource management tool for other actors in the supply chain. That is why “reuse” is not an individual step in the waste hierarchy, as the only actor who can in practice reuse anything is the consumer. Nevertheless, the waste hierarchy may in other versions inspire and apply better as an overall resource management tool applicable to other actors than waste managers, including policy makers (Gharfalkar et al., 2015).

2.1.2. A NEW PARADIGM?

Bartl (2014) and Gharfalkar et al. (2015) view the waste hierarchy as a recommendation on how to address the issue of the loss of depletion of natural resources and environmental degradation. Waste is no longer predominantly seen as a problem of toxicity and pollution, but a question of resources that are not utilized efficiently (Blomsma & Brennan, 2017). Corvellec & Hultman (2012) argue that a changed societal narrative regarding waste has taken place. The changed societal narrative concerning waste implies that waste management principles have changed from being based on environmental concerns to now also encompassing economic and value creation concerns (Corvellec & Hultman, 2012). This could imply a contradiction between the aim of avoiding waste through preventive measures and

extracting value from waste. Corvellec & Hultman (2012) argues that there is a duality within waste governance policies, but that this divide is annihilated in the waste hierarchy because “prevention” is placed so clearly as first priority. Paradoxically, prevention is the management option receiving the least attention and allocation of resources (Zacho & Mosgaard, 2016) (for more see chapter 5). Another paradox is that “*waste managers are practically powerless when it comes to prevention*” (van Ewijk & Stegemann, 2014: 4), so how are they to prioritize prevention when they have no control of it? Given that waste managers are required to achieve certain quantitative collection goals, there may even be opposing interests embedded in EUs indicators for circular waste management. The waste hierarchy is moreover commonly perceived as a ladder that one should “move up” (van Ewijk & Stegemann, 2014; I. Williams, 2015). However, this is a misconception, which I also discuss in my review article (A) on waste prevention in chapter 5 (Zacho & Mosgaard, 2016).

2.2. THE CONCEPT OF THE CIRCULAR ECONOMY

The concept of the circular economy has gained ground during the last decade (Ghisellini, Cialani, & Ulgiati, 2016; Geissdoerfer, Savaget, Bocken, & Jan, 2017). Particularly since the first report from the Ellen MacArthur Foundation (Macarthur, 2013) was published in 2012, the concept has gained popularity in industry, science and policy. This is evidenced by the tremendous increase in scientific publications concerning the topic (Geissdoerfer et al., 2017). Similarly, the European Circular Economy Packages (European Commission, 2015; European Commission, 2017b) are signs of the increasing uptake of the concept by policymakers.

The Circular Economy is presented as a break with the production and consumption models, called the linear economy, or the “take-make-dispose” model (Macarthur, 2013). Here the “take” refers to natural resource extraction, the “make” refers to the production of goods, and the “dispose” refers to the waste disposal after use. The rate with which natural resources are currently extracted and used exceed the rate with which they can be renewed (WWF, 2016). Additionally, forecasts predict that in 2050 the annually consumed volume of mineral ores and fossil fuels will have tripled (UNEP, 2011). The increasing affluence particularly in the western world combined with an increasing population in the developing world put pressure on the earth’s ecosystems. At the same time, waste generation per capita in Europe remains high despite a slight decrease during the recent decade (Eurostat, 2017a) (see graphic presentation of generated amounts of waste per capita in EU 27 in figure 2.2).

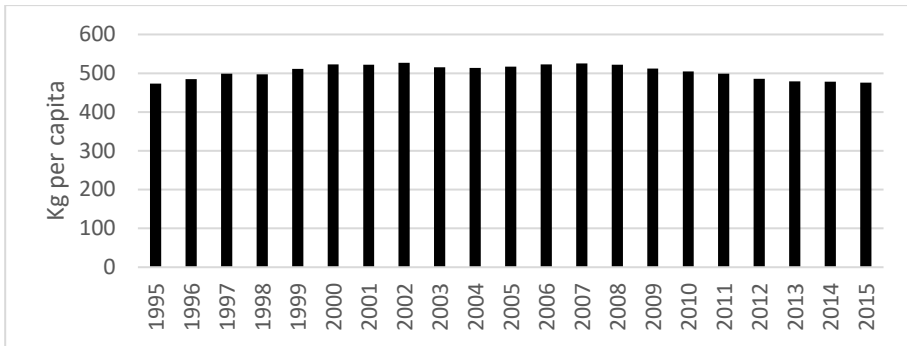


Figure 2.2 The generated amounts of waste per capita in EU 27 have generally been high during the last 20 years, however also remarkably stable (Eurostat, 2017a)

The predominant waste management solutions in Europe have so far not been circular, with landfilling accounting for 28 % and incineration accounting for 27 % in 2014 (Eurostat, 2016).

Circular economy presents a vision of a future society, in which the physical flows of resources are managed more efficiently and systems of consumption and production are designed to be intentionally restorative and regenerative (Webster, 2015). The basic strategies to achieve such a society are to minimize material use; design out waste; use renewable energy only; and extract the maximum value of resource use (Macarthur, 2013). In practice, this would imply a replacement of landfilling and incineration with other methods that extract the materials within the waste to be utilized more efficiently and replace raw material extraction thereby eliminating waste. This idea of a closed loop economy is not new, and neither are the basic thoughts behind the concept (Bocken, de Pauw, Bakker, & van der Grinten, 2016; Charonis, 2012; Geissdoerfer et al., 2017). What is new is the framing and packaging of the ideas, and the significant attraction the circular economy concept has achieved today.

In this section, the central thoughts and principles of the circular economy concept will be presented, subsequently leading to a framework of how a waste management company can innovate their business model with an outset in the circular economy concept. Throughout the chapter, the concept is discussed in relation to sustainability, since I as a researcher within sustainability science ultimately aim for contributing to a sustainable development, i.e. a development that meets human needs within the boundaries of the planet's capacity to regenerate. A development that sustains the planet in a condition where life can flourish. Hence, reflections about the circular economy's ability to contribute to this will be included. Secondly, I will discuss how the concept can work as a social and cognitive construct that can inspire and guide organizations and businesses to transition towards a more sustainable direction.

2.2.1. THE MAIN THOUGHTS AND PRINCIPLES IN THE CIRCULAR ECONOMY

Even though, the circular economy concept concerns the recirculation and reutilization of materials, the concept is not merely presenting new waste management solutions. Reuse, recycling and resource recovery as described within the waste hierarchy framework are indeed the main strategies for narrowing, slowing and closing material loops, but a core idea of the circular economy is that these strategies should be taken into consideration at all stages of the value chain (Ghisellini et al., 2016; Macarthur, 2013). Thus, the concept is in tune with life cycle thinking, and the enabling of circularity should be inherent in product designs (Bakker, Wang, Huisman, & Den Hollander, 2014)

The basic circular strategies from an industry perspective are

- Minimization of material use;
- Designing out waste from products and production processes, so products are designed for longevity, multiple lifecycles and for their material content to be recovered. This can be enabled through design, by the disassembly, repair, reuse, refurbishment, remanufacturing and the recycling of materials in the product, keeping resources in circulation for as long as possible;
- Employing renewable energy;
- Extracting the maximum value throughout these processes.

(Macarthur, 2013)

The circular economy is often depicted as material circles going from the latter parts of the value chain (end of use phase) back to the production phase, symbolizing reuse and recycling. Figure 2.3 shows this cyclical presentation of material flows in the circular economy.

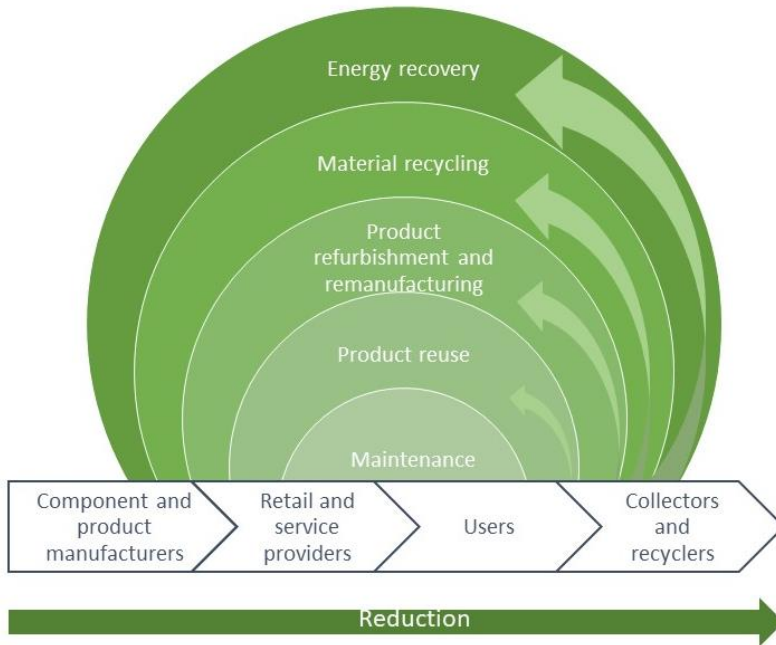


Figure 2.3 In circular economy conceptualizations, the material flows are often depicted as circular flows from the end-of-use phase back to production

Figure 2.3 shows the return flows of materials. In that sense, it is another way of illustrating the waste hierarchy, where the relevant actors are included. In the circular economy, the same order of preference is present as in the waste hierarchy.

The additional principle that value should be created and extracted does not fully show in the figure. Some scholars place emphasis on the value creation and others place emphasis on the minimization of material flows, and whether both can be achieved at the same time is unclear. These two principles of the circular economy there is not yet consensus about.

Bocken et al., (2016) make a distinction between slowing, closing and narrowing resource loops. Slowing the loops refers to the prolongation of the useful lifetime, i.e. through maintenance, repair and reuse. Narrowing refers to the minimization of materials used for production, and closing loops refers to reuse of materials through recycling. These different circular strategies make this distinction clear in order to address the fact that a sole focus on material efficiency (narrowing) implies a risk of rebound effects (e.g. more frequent product replacement will offset the

environmental benefits gained from decreased material use), illustrating the potentially conflicting aims of value extraction and reduction of resource flows.

Another important principle is to keep the cycles pure, i.e. uncontaminated by harmful substances, but also by not mixing materials unnecessarily as this will reduce the ability to recirculate or regenerate the materials.

Ellen MacArthur Foundation distinguishes between a biological cycle and a technical cycle (EMF, 2013) in order address the fact that for instance organic waste cannot be reused but can be transformed to energy and fertilizer.

From an industrial perspective, the aim of these circularity strategies is to decouple revenues in companies from the material input (Charonis, 2012). Companies are expected to save money on material input, experience a more secure supply of materials not vulnerable to price volatility or geopolitical turbulence, thus also becoming more resilient (Macarthur, 2013).

The circularity strategies are similar to the Cradle-to-Cradle concept's strategies (McDonough & Braungart, 2002). In fact, there are multiple overlaps between the two concepts. One major difference is that the cradle-to-cradle concept is a certification scheme. Though this implies some advantages, it also has the disadvantage of requiring many resources for businesses and organizations to become certified. This may have discouraged businesses to embark upon cradle-to-cradle. The circular economy concept is free for everyone to use, and this is reflected in the circular economy principle of "transparency" (see below).

The circular economy concept encompasses more than strategies for designing products and business models for circularity. The BS 8001 standard includes six additional principles to be applied when business models for circularity are to be developed:

- Systems thinking
- Innovation
- Stewardship
- Collaboration
- Value optimization
- Transparency

In the BSI Circular Economy standard (BS 8001), systems thinking is defined as *"an understanding of how organizations, individual decisions and activities interact within the wider system they are part of"* (BSI, 2017). **Systems thinking** is thus about understanding the system in which the organization is a part, understanding the parts of the whole and the relations between the parts (Meadows & Wright, 2008). Systems thinking is one of the most important principles in the circular

economy (Mentink, 2014), because several actors and activities within the entire supply chain are involved before the material loops can successfully be closed. Every single part of the supply chain, every relation between the companies and actors engaged in the process needs to support the closing of the loops. Moreover, a lack of understanding the system may lead to rebound effects or suboptimal solutions (as for example the promotion of bioplastics within a system with no composting of waste). The systems thinking can even be expanded to all living systems; a mental model in which the connectedness and integrated relationships between society and nature is also considered. For an organization to transition to a circular economy and to develop resilient circular business models, understanding the parts of the supply chain and their relation, as well as the connectedness between different activities and the natural environment, is a prerequisite. The principle of **Collaboration** is related to the systems thinking, as collaboration between actors in the network is necessary. This emphasis on collaboration between stakeholders as vital for the achievement of goals, the circular economy concept has in common with the sustainability concept (Geissdoerfer et al., 2017). Associated with the collaboration principle are the principles of transparency and innovation. Collaborations tend to function better when trust and **transparency** is present. Moreover, transparency is a tool to disseminate the circular economy. **Innovation** can be encouraged through new collaborations. Moreover, innovation within products and business models are required as the CE strategies require new ways of doing business. A key principle related to this is that the value of products, components and materials is sought optimized (**value optimization**). In order to do so, organizations should take responsibility and manage the direct and indirect impacts of their activities through **stewardship** (BSI, 2017).

2.2.2. VALUE CREATION AND/OR MATERIAL FLOW MINIMIZATION

The concept of the circular economy holds both a vision of a society in which material loops are minimized and closed and resource input and waste are eliminated as well as a vision of creating value from this. Emphasis are to various degrees put either on the value creating aspect or on minimizing material throughput. For instance, the Ellen MacArthur Foundation places much emphasis on the value creation potentials. This is evident in the circular economy definition by Webster:

“a circular economy is one that is restorative by design, and which aims to keep products, components and materials at their highest utility and value, at all times”

(Webster, 2015)

This definition has positive connotations, and the Ellen MacArthur Foundation has significantly managed to promote the circular economy concept and put it on the agenda, possibly through an emphasis on the possibilities for economic gains through the circular principles (Kirschherr, Reike, & Hekkert, 2017).

In comparison, Geissdoerfer et al. (2017) places emphasis on the more concrete ways of implementing the circular economy as *“a regenerative system in which resource input and waste, emissions, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, and repair, reuse, remanufacturing, refurbishing and recycling”*.

This definition does on include considerations of value creation. To bring matters to the head, the two definitions are examples of how the circular economy can be perceived as either a tool for economic growth or a tool for resource conservation. Other authors argue, that the aim of a circular economy should be a sustainable development (Kirschherr et al., 2017). Whether such a circular economic system can actually be sustainable, i.e. balancing environmental, economic and social aspects is more uncertain (as discussed below). For instance, completely closed material loops are physically impossible to achieve (for more see for instance Geyer, Kuczenski, Zink, & Henderson, (2016); Moreno, Braithwaite, & Cooper, (2014); Zink & Geyer, (2017); Andersen (2007). On the other hand, a sole focus of maximizing value does not necessarily imply reduced environmental impacts. Kirschherr et al. (2017) and Geissdoerfer, et al. (2017) moreover found, that the social dimension of sustainability is often neglected in circular economy conceptualizations.

2.2.2.1 Circular economy and economic growth

The circular economy principles of material re-utilization is fundamentally based on physical rather than economic observations (M. S. Andersen, 2007). Nevertheless, as *“Circular Economy”* implies, we have to do with an *economic* model, which supposedly are to challenge the economy model dominant in today’s societies (Ghisellini et al., 2016). The mainstream economy of industrialized countries pursues economic growth through a reliance on the availability of cheap and abundant resources, and on nature’s ecosystems as absorber of waste and emissions. The circular economy is a vision of a new economic system relying not on additional virgin resources, but on a restoration and regeneration of resources. A circular economy thus builds upon some of the same physical principles and goals as Steady-state economy and de-growth economy (Charonis, 2012), in which recirculation of resources are also required. Yet, in contrast to these two concepts, a circular economy is also an economy in growth. Nearly all developed nation has the paramount policy objective of pursuing growth in GDP (Charonis, 2012). Hence, the circular economy’s prospects of enabling a decoupling of economic growth from environmental impacts are appealing, which may be why China and the EU have adopted the concept. The anticipations of the economic perspectives of circular economy for Europe are for instance evident in the way the European Commission communicates:

“The transition towards a more circular economy brings great opportunities for Europe and its citizens. It is an important part of our efforts to modernize and transform the European economy, shifting it towards a more sustainable direction. There is a strong business case behind it, which enables companies to make substantial economic gains and become more competitive. It delivers important energy savings and environmental benefits. It creates local jobs and opportunities for social integration. It is closely interlinked with key EU priorities on jobs and growth, investments, the social agenda and industrial innovation.”

(European Commission, 2017b)

At macro scale and from an environmental perspective, there is a need for increased resource efficiency through reductions and more circular flows of materials. But whether increased resource efficiency will bring about the economic advantages and growth opportunities envisaged by some circular economy advocates, such as the Ellen MacArthur Foundation, is more uncertain. The circular economy has not yet been tried and tested at large scale, and hence, this topic is among some of the less developed aspects of the concept to date, and their validity has yet to be confirmed (Blomsma & Brennan, 2017; Charonis, 2012; Ghisellini et al., 2016).

2.2.2.2 Circular economy and sustainability

The linkages of circular economy to sustainability has been debated in scientific literature e.g. Geissdoerfer et al. (2017); Hobson (2016); Mentink (2014); Gregson, Crang, Fuller, & Holmes (2015); Loiseau et al., (2016) and Kirschherr et al., (2017) and there seem to be disagreement among authors about how well the circular economy promotes a sustainable development. A “sustainable development” does not point towards specific actions or a precise content, but overall it aims at continuously balancing social, economic and ecological values (Lélé, 1991). I understand sustainable development as a development that sustains the planet in a condition where all forms of life can flourish now and in the future.

Assessing the circular economy concept through this sustainability lens, the concept comes short in addressing what prosperity means apart from the ability to consume materially. The concept has been criticized for coming short on social aspects like labor conditions, wealth distribution, equity, health and socio-cultural aspects, and personal well-being (Hobson, 2016; Moreau, Sahakian, van Griethuysen, Vuille, & Vuille, 2017). From a sustainability perspective, most conceptualization of the circular economy places most emphasis on the two pillars of sustainability, i.e. economy and a (somewhat simplified) environmental perspective, rather than on the third pillar, i.e. the social aspects. When social aspects are mentioned in circular economy literature, they mainly concern job creation (Geissdoerfer et al., 2017). The concept moreover primarily focuses on market based solutions and regulatory frameworks for this. The aim of the a circular economy is to decouple environmental

impacts and resource consumption from economic growth, not from human well-being as suggested by Jackson (2009). At this point, the concept also distinguishes from the Steady State economy and de-growth, in which the aim of social equitability is put to the forefront of the definitions (Charonis, 2012). Moreover, the underlying perception of nature as something that provides resources and ecosystem services to maximize the utility for human beings is somewhat anthropocentric. Is biodiversity for instance a value in the circular economy regardless of its utility for humans? For these reasons, the concept of the circular economy cannot substitute sustainability management, but the circular economy can be seen as an important aspect of sustainability. In this regard, the circular economy concept provides operation tools for companies to apply as part of their wider sustainability management. From this perspective, the strength of the circular economy concept mainly lies within its practical applicability for business actors, not as a macro-economic alternative to contemporary mainstream economy.

Though interesting, the macroeconomic perspectives of the circular economy are not central to this study. In this study, I delimit my research from assessments of whether a transition in line with the circular economy principles will actually be sufficient to create a sustainable future development at societal level, i.e. an economy that works within the boundaries of the earth's ecosystem services and ensures human well-being now and in the future. I apply the concept to a specific case in recognition of 1) the overall need to develop new ways of using resources more efficiently, and 2) the practical strategic framework that the circular economy concept provides. The down-to-earth strategies for a circular economy will be elaborated in the following.

2.2.2.3 Circular Economy principles and enablers

Where the circular economy concept may be somewhat underdeveloped concerning the macroeconomic perspectives, its strength lies within its relevance and applicability for business actors and for policy makers designing incentive structures for business actors (Geissdoerfer et al., 2017). Private businesses and organizations play a central and determining role for a transition towards a sustainable development (Shaltegger, Hansen, & Lüdeke-Freund, 2016) including the realization of circular flows. The practical framework that the circular economy concept offers businesses and organizations is the most developed and institutionalized part of the concept. For example, in June 2017, the British Standard, the “BS 8001 *Framework for implementing the principles of the circular economy in organizations –guide*” was launched. The fact that an established standard exists shows that the circular economy concept is becoming increasingly institutionalized.

In comparison to the concept of sustainability, the circular economy provides quite clear and easily communicable strategies and principles for businesses and

organizations. Previous approaches to sustainable development in businesses, such as corporate social responsibility, technological process and product innovation, has not brought about sufficient changes necessary for a larger socio-technical transition to a sustainable development (Shaltegger et al., 2016; Geissdoerfer et al., 2017). The business model-orientation intrinsic in the circular economy concept and its quite specific circular strategies is one of the aspects that distinguishes the concept from the broader concept of sustainability.

2.2.3. THE CIRCULAR ECONOMY AS A COGNITIVE MODEL FOR DEVELOPING NEW RESOURCE EFFICIENT STRATEGIES

Blomsma & Brennan (2017) suggest that the strength of the concept is that it offers a new *framing* of the strategies of the waste hierarchy in combination with other principles such as pollution prevention and resource efficiency. They view the circular economy as an umbrella concept *“creating a cognitive unit and a discursive space that centers on the capacity of a group of waste and resource management strategies to extend productive life of resources”*. The circular economy concept can thus be perceived as a framing or *“a set of ideas, [...], with the capacity to be used as a basis for collective action”*. Some of the discursive elements of the circular economy may best be understood by comparing it to previous discourses on waste and resources management. In the current circular economy discourse, waste is seen as a valuable resource that should be utilized by private business actors for profit maximization and resource security. This way of perceiving waste contrasts previous discourses. In the 60's -70's the central concerns of waste to policies and science were related to the toxicity, scarcity, the polluting effects of waste, and problems with space for landfills were. Managing these negative effects were primarily by end-of-life technologies like waste-to-energy, recycling and composting (Blomsma & Brennan, 2017). In other words, waste was perceived as something negative, environmentally harmful and costly. Thus, the prevailing perception of waste is changing *“from having been something to get rid of and made to cognitively and geographically disappear, waste is increasingly framed as both a value reservoir that is worth competing for and something unwanted to be minimized”* (Corvellec & Hultman, 2012: 303). This view may be a bit exaggerated, since reuse and recycling were also debated in the 60s and 70s. But the specific targeting of businesses by organizations like the Ellen MacArthur Foundation and the Cradle-to-Cradle has had a promoting effect on establishing a new discursive paradigm around resources and waste, which is much more positive and potential oriented than previously. Hence, circular economy as a discourse or a societal narrative on waste and resource can form a basis for collective action towards a wider socio-institutional change. However, as also pointed out above, the concept still lacks theoretical clarity, and it will thus undergo further scrutiny and development.

2.3. HOW THE CIRCULAR ECONOMY SUPPLEMENTS THE WASTE HIERARCHY

Through the above examination of the two concepts, the waste hierarchy and the circular economy, differences and similarities have appeared. The concept of the circular economy provides a vision of an economic system, including practical strategies on how to achieve this. The circular economy strategies are always depicted as cyclical flows, hence the name “circular”. Apart from its cyclical appearance, the circular strategies do not differ much from the triangular presentation of the waste hierarchy management options. A difference is in the way they are presented and to whom they target. The waste hierarchy mainly provides solutions on how to manage products and materials, once they have become waste. This is a reactive approach, whereas the circular economy aims to incorporate these considerations in the design of products and business models, thus taking a proactive approach. Thus, the waste hierarchy mainly addresses waste managers, and the circular economy addresses other types of businesses and organizations, however not excluding waste managers. The circular economy concept does in addition to its strategies, hold some additional principles (systems thinking, innovation, collaboration, stewardship, value optimization and transparency) which is not present in the waste hierarchy.

Where the waste hierarchy is clear in its priority of prevention, prevention is not given the same preference by all authors within the circular economy. For instance, the Ellen MacArthur Foundation does not place much emphasis on prevention, whereas other authors like Bocken et al. (2016) and Geissdoerfer et al. (2017) do by putting to the forefront the *slowing* of loops. The position of prevention is one of the aspects within which the circular economy concepts lacks consensus and common understanding among actors. Is a decreased total per capita consumption a necessity to achieve a circular economy, or does the perpetuate circulation of products and resources enable high-frequency replacement of products by consumers? Apart from prevention, the same priority is given to the subsequent management options as in the waste hierarchy with a few differences, however mainly in wording. For instance, “Prepare for reuse” is a phrase only used in waste legislation that corresponds to the circle of remanufacture and refurbish as an activity conducted by other actors than the user after the user have chosen to discard the product. *Repair* on the other hand, is both in the circular economy and the waste hierarchy considered a preventive measure that prolongs the useful lifetime of a product. Figure 2.4 illustrates the similarities between the waste hierarchy management options and the circular economy resource strategies.

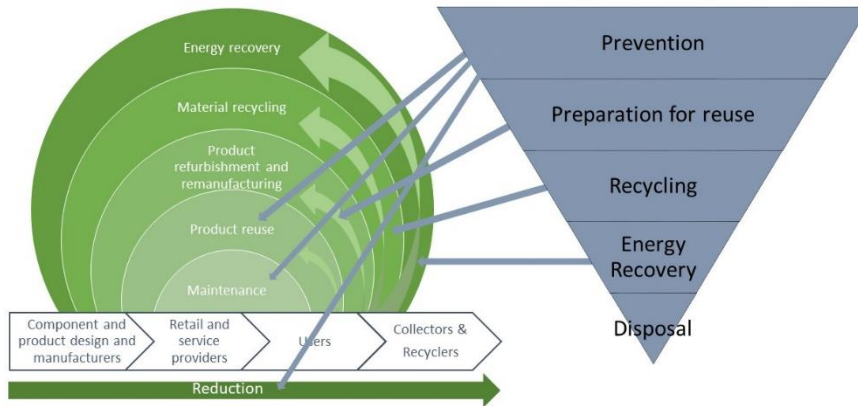


Figure 2.4 The principles of the waste hierarchy are the same as in the circular economy. In the circular economy concept, these strategies are linked to actors in the value chain

With regards to waste-to-energy, this rarely plays a role in circular economy literature, but is present in the waste hierarchy. Incineration is from an outset in the circular economy concept considered part of the linear economy. However, there is room for interpretations of this. For instance, the European Commission (2017a: 10) states that “*Waste-to-energy processes can play a role in the transition to a circular economy provided that the EU waste hierarchy is used as a guiding principle and that choices made do not prevent higher levels of prevention, reuse and recycling.*” This additionally shows that within EU, “circular economy” is a term used to describe a desired *economic/industrial system*, and that the waste hierarchy is promoted as the guiding principle to achieve this. Given the impossibility of perpetual recycling, there will always be a need to supplement reuse and recycling with incineration. For this reason, I have included incineration with energy recovery in my figure of the circular resource flows.

In the vision of a fully implemented circular economy, there ideally will be no waste. Everything will be designed in a way that enables circulation of products and materials, and business networks will manage this circulation in collaboration. Consequently, there would be no need for waste management as the centralized system we know today. This vision is however utopian. Firstly, perpetual recycling is physically impossible. This is due to the second law of thermodynamics. This law concerns *entropy* which describes how well material is organized (M. S. Andersen, 2007). The more chaotic and disorderly something is, the higher the entropy. This also implies that the actions and resources required re-creating order increases. As an example, wood fibers used in paper production can be used up to seven times before they are too degraded for further use. For the recycling process of paper to

function, new wood fibers need to be added each time the paper is to be recirculated. The second law of thermodynamics thus applies to wood fibers in paper, but also to fossil fuels, metals and other material. Hence, a fully closed material cycle is not possible.

Secondly, the pool of products and materials, which are currently in use in the economy, was not initially designed for a circular economy. These products and materials will eventually become waste, and therefore there will be need for waste managers in the future. Besides, there is also a need for people to manage the flows, so in other words, waste managers have to become resource managers. Additionally, some materials and substances previously used should for environmental reasons not be circulated. This includes for instance mercury and asbestos. Hence, disposal in landfilling will not be completely eliminated in the near future.

2.3.1. SUMMARY

The circular economy resource strategies and the waste hierarchy management options are similar with only minor differences, mainly due to their different target groups. What distinguishes the concepts are that the circular economy concept encompasses more than the resource *strategies* for circularity. The business perspectives that the concept encompasses adds new perspectives as to how circularity of products and materials can be incorporated in business strategies and plans. For the waste sector, currently governed by the waste hierarchy, there are thus new insights to acquire from the circular economy concept. These regard a change of mindset from seeing waste as a problem to be solved, to seeing waste as new business opportunities, (whether these business opportunities then actually exist for waste managers will be part of the further my analysis). Moreover, the circular economy concept at a more overall level brings to the forth innovation in products and business models. It places an emphasis on the thinking in systems and on the creation of new types of collaboration between actors that may not traditionally have collaborated.

As emphasized by Geissdoerfer et al. (2017) and Shaltegger et al., (2016), business model innovation is increasingly seen as the key pathway to sustainable transition of society. As the circular economy concept is quite business oriented, business model innovation from a circular economy outset has received increasing attention in recent years, for instance by Bocken et al., (2016), Lewandowski (2016), Planing, (2014) and Mentink (2014). Lewandowski (2016) points out that a *"heavily underexplored area is related to applying circularity to business models of public sector organizations"*. In this thesis, I will take this as a challenge and begin exploring how the circular economy concept can be applied to the business models of a public waste management company. Firstly, however, I will outline a conceptual frame for the *Circular Business Model* and how innovation in this can be conceived.

2.4. CIRCULAR ECONOMY BUSINESS MODELS

In order to investigate how AVV can transform their waste management business in line with the circular economy principles and how this will affect the company and its operations, I will unfold the concept of the business models in the following section.

The concept of business models differs from the concept of *strategy* (Teece, 2010; Osterwalder 2004). Strategy and business models are different layers in our understanding of businesses. Where *strategy* concerns visions and goals, *business models* are the translation of the strategy into the architectural level of how value is captured. Beneath this level, are the actual workflows in the organization. This trichotomy of business understanding is illustrated in table 2.1.

Planning level	Strategic layer	Visions, goals and objectives
Architectural level	Business model layer	Money earning logic
Implementation level	Process layer	Organization and workflow

Table 2.1: Layers in understanding business. At strategic level, the visions and goals are set. The business model level defines how value is captured. And the implementation level is more operational and includes the daily workflows and practices (Osterwalder, 2004)

To embark upon circular business model innovation requires fundamental changes in the purpose of a business, i.e. the strategic layer (Bocken et al. 2014), but it is in the architectural design of the business models that the potentials and challenges of the circular economy truly become tangible and applicable. It is also at this level that innovation for a circular economy occurs.

2.4.1. WHAT IS A BUSINESS MODEL?

The business model concept is a fairly new concept that emerged in the late 20th century (Shaltegger et al., 2016; Zott, Amit, & Massa, 2011). The concept is used to describe and analyze how a company creates value, how it delivers value to its customers and how it captures value (Magretta, 2002; Osterwalder & Pigneur, 2010). Teece (2010) defines it:

“A business model describes the design or architecture of the value creation, delivery and capture mechanisms employed. The essence of a business model is that it crystallizes customer needs and ability to pay, defines the manner by which the business enterprise responds to and delivers value to customers, entices customers

to pay for value, and converts those payments to profit through the proper design and operation of the various elements of the value chain. (p. 179)

A well-known business model conceptualizations is that of Osterwalder and Pigneur (2010); *the business model canvas*. This model visualizes the business as a system comprised by a number of components centered around the *value proposition related to a product or a service*. The components comprise *customers*, *the relationships* with these customers, and *the channels* to sale and communicate with customers. In figure 2.5, this is the right side of the model, i.e. the aspects that has to do with how value is delivered and to whom. The left side of the model comprises the *key activities* conducted in a company to create value. This relates to the *resources* in the company and also the *key partners* with whom the company collaborates to create the value, for instance suppliers of materials. The value creation side requires costs, whereas the value delivery side generates *revenue flows*. In other words, the business model canvas groups cost and benefits. The canvas has an explicit economic value orientation. In other words, the business model specifies how the company earns money, and the purpose of working with the business model is to improve it in order to maximize profits.

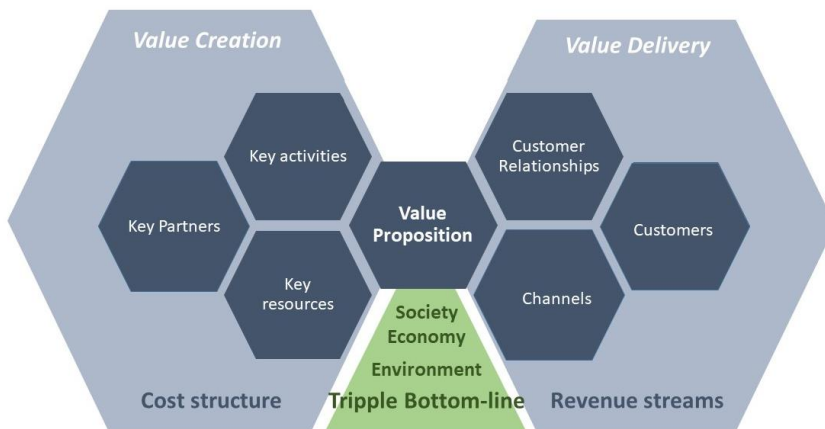


Figure 2.5 A business model comprises how value is created, delivered and captured, and which elements come at play in this process. The business model is in its outset aiming to create economic value, but a sustainability bottom-line can be added to the model, thus adding the aims of environmental and social value (based on Joyce & Paquin, 2016; Osterwalder & Pigneur, 2010)

The business model canvas provides an illustrative overview of the elements constituting a generic business model and how the elements are interlinked. Applying this generic model to an existing company can be a useful tool to describe, analyze and understand how the elements in the actual business are interlinked. This is the first step to innovate the business model. Even though, the business model concept is originally aimed at private businesses, the model can also be useful to apply to public companies. Rappa (2004) writes, *“To understand the nature of the utility model, it is useful to place it in the context of business models in general”*. AVV offers waste management as a utility model, and they provide value to a certain set of customers and has costs and revenues related to this. The business model perspective can provide a different way of considering how value can be created from waste.

2.4.2. THE PUBLIC UTILITY

Business models are fundamentally about how to organize your business with the aim of maximizing profits. Danish waste management companies, like AVV, are public utility companies, and public utilities operate according to a non-profit principle. The main goal is not to make a profit, but to carry out laws and other general rules in practice in an efficient manner (Christensen, 1980: 12). Public companies may also have a more distinct responsibility for directing society in a sustainable development than private companies do. Therefore, circular business model innovation is relevant for public utilities too. For this reason, I will in this thesis work with a tripled layered business model, which aims at balancing finances, and creating social justice and ecological integrity.

Public utility companies are organizations, which are linked to the political system. Therefore, the political system perceives the utilities as the organization through which the political system works. Organizations like AVV will thus always be subjected to the political system. However, public utilities are not just dominated by the control logic of the political system. Increasingly, they are dominated by many different societal logics, and the management of these can sometimes become an orchestration of opposing logics (Andersen, 2014).

Still, the business model concept is useful in the context of AVV, because it can be used as an analytical tool to analyze, understand and develop new ways of handling waste that are more circular, i.e. which creates value from waste and thereby prolongs the life of products and directs waste materials back into the economy.

Not all the ideas of the circular economy are applicable to AVV. For instance, virtualization and leasing models may be of less relevance.

2.4.3. A SPECTRUM OF CIRCULARITY

“Simply put, there are two types of business models within the circular economy: those that prolong the lifetime of products e.g. through reuse and repair, and those that recover the materials within the products to be used attain for production of new things”

(Stahel, 2016)

A circular business model does not imply that material loops are fully closed by the operations of one business. Most often, circularity is enabled by the actions of multiple actors throughout the supply chain or within a network of businesses. Circularity moreover seems to be within a spectrum rather than an either/or. For instance, a company can choose to replace their raw material input to the production to an input of recycled material. This makes the business *more* circular, but not necessarily as circular as it could potentially be. Moreover, such a shift to recycled materials does not require comprehensive changes to the business model. Likewise, it could be argued that a recycling company already operates within and supports the circular economy. Does this then mean, that the company cannot become more circular? Circularity thus seems to work within a spectrum of opportunities, and it may vary to what extent a change towards circularity requires changes within the business model.

2.5. CIRCULAR BUSINESS MODELS INNOVATION AS A FRAMEWORK FOR DEVELOPING NEW WASTE MANAGEMENT SOLUTIONS

2.5.1. CIRCULAR BUSINESS MODELS INNOVATION

Business model innovation is a process in which a new business model is designed and implemented. This does not necessarily imply changing the entire organization, but it is a more comprehensive process than traditional product innovation. The intended result of business model innovation is to develop a new system (not just a new product or process) that can create value beyond what the company or the market previously has seen. Business model innovation (BMI) is a distinctive process because the innovation occurs at the system level. This is unlike other types of innovation such as product – and process innovation. In BMI, several of the business model components and their interdependence are affected and this implies a higher degree of uncertainty in BMI than in traditional product innovation. Such uncertainties regard what the value proposition should be, whether there will be demand for the new product or service, which new partnerships to engage with etc.

Business model innovation may encompass changes in the way the products and services are delivered to the customers, changes in partnerships, distribution

channels etc. A business model may also be successful because it creates new, incremental demands (Magretta, 2002), i.e. when the company seeks to affect and actively change the market in their favor.

Applying circular economy principles in a company will potentially affect several elements of a business model, if not the entire business model. This is unlike previous “green concepts”, such as environmental management systems and eco-design, which aim at greening the production or greening the products, respectively (Bocken et al., 2015). Production processes and the core products are limited elements of a business model, and changing these may only affect other element of the BM to a minor degree, such as the supply chain management or the way products are marketed. In comparison, a circular economy approach will inevitably encompass changes in more elements in the business model than these other green approaches. The product (or service) may change, so may the targeted customers and the relations to these as well as the production processes. Collaborating with new partners is a key aspect of the concept, and new types of collaborations in new networks may be the catalyzing factor for innovation and the realization of circularity in an organization or a network of organizations. Thus, innovation in the business model is an obvious way to embark upon the work with implementing circular economy in a company.

The way business models are defined, emphasis is on value creation and value capture. A basic aspect of a business is to make profit. However, literature on sustainable business models emphasize that a green business model is about more than making money (Bocken et al., 2014; Lüdeke-Freund, 2013; Roos, 2014). Apart from the challenge of appropriating monetary value from the customers, a green business model also has the purpose of creating a multidimensional value for stakeholders. Stakeholder collaboration is increasingly emphasized as vital, as sustainability cannot be achieved by companies acting autonomously (Bocken et al., 2014).

Bocken et al. 2014 defines business model innovation for sustainability as *“innovations that create significant positive and/or significantly reduced negative impacts for the environment and/or society, through changes in the way the organization and its value-network create, deliver and capture value (i.e. create economic value) or change their value propositions”*. This definition puts emphasis on the positive effects for the environment and society in addition to the economic. In comparison, other definitions of circular business models are much closer linked to the original definition of business models, i.e. the emphasis is on the aim of making profit through efficient use of the materials and used products. Recent examples of definitions of circular business models are:

Linder, Williander, & Williander (2017): *“a business model in which the conceptual logic for value creation is based on utilizing economic value retained in products after use in the production of new offerings”*,

Mentink (2014): *“the rationale of how an organization creates, delivers and captures value with and within closed material loops.*

With these prevailing definitions in literature, *“circular business model do not necessarily aim to balance ecological, social and economic needs”* (Lewandowski, 2016; Mentink, 2014). This is in contrast to business models for sustainability, which aims to create value in a triple layered bottom-line (Joyce & Paquin, 2016).

I have chosen to adhere to a definition of the circular economy, which aims for sustainable development. Therefore, circular business model innovation should aim for creating both environmental, social and economic value. Besides, a public actor, ought to have a more distinct responsibility to support and foster a sustainable development. For this reason, I will use the business model concept in combination with the triple layered bottom-line and the circular strategies.

2.5.2. BENEFITS AND BARRIERS FOR CIRCULAR BUSINESS MODEL INNOVATION

The companies who already operate a circular business model unsurprisingly do it, because of economic benefits (Incentive, 2015). But if the business economic benefits were so obvious, why are circular business models not more common? Uncertainties and little evidence about the economic benefits for the individual company, i.e. the balancing of the needed investments in new technology, resources and labor and potential revenues from sales, is seen as an obstacle for companies to embark upon circular business models (Guldmann & Huulgaard, n.d.).

Increasing and/or fluctuating prices of raw materials have been used as an argument for companies to implement circular strategies. However, this assumed price pressure is not experienced by all companies (Guldmann & Huulgaard, n.d.), and for instance the difference between the price of virgin materials and secondary raw materials is not always significant or to the benefit of the secondary material (“Letsrecycle.com,” 2016).

Another potential benefit regards the potential positive public relations, branding value and press coverage that a company can gain from circular innovations. Similarly, circular innovations are emphasized as providing companies with a competitive advantage due to differentiation from other competitive companies. This is only valid if there is a market for the products/services in the circular business model or if there is an isomorphic pressure or a general consensus in the organizational landscape that circular economy is the right thing to do.

This advantage is not obvious to all companies who consider circular business model innovation. Market demands are unclear (Guldmann & Huulgaard, 2017), and the consumer willingness to buy remanufactured products or engage in product service systems are unclear (Planing, 2014).

Some companies in previous circular economy projects have struggled to establish cross-organizational collaborations. As stakeholder collaboration is seen to be essential to circular business model innovation (Kraaijenhagen, van Oppen, & Bocken, 2016), this is problematic.

2.5.3. DEALING WITH UNCERTAINTY

There thus seem to be both uncertainty about a) the need or the benefits of engaging in circular business model innovation, and b) how to innovate business and models and systems towards circularity. Moreover, there may be conflicting goals, such as reduction vs value creation, and when collaborating with other stakeholders there is a high probability that there will be different goals and/or different opinions about the means to reach the goals. How to deal with this? How to plan the process of innovating the business model in line with circular economy principles when there are all these uncertainties both regarding means and ends? Traditionally, the task of planning is assumed that both means and ends are known, but this is rarely the case (K. S. Christensen, 1985).

Kjær and Vendelø (2014) point towards the fact that planners and decision makers, be it CEOs, managers or employees, are limited by their own skills, knowledge, habits, values and imaginations about the goal. Moreover, decision making processes in organizations are often characterized by diverse, conflicting goals, limited information and limited resources. Just as the conception about the rational economic man is insufficient, the conception about the rational administrative man/company is also insufficient.

Christensen (1985) identifies and discusses the implications of four different combinations of known/unknown means and goals (presented in figure 2.6 below). She writes that *“if planners can agree on what they want, but do not know how to achieve alternatives, then planning becomes a learning process; if they do not agree on what they want but do know how to achieve alternatives, then planning becomes a bargaining process; if they agree on neither means nor ends, then planning becomes part of a search for order in chaos”* (K. S. Christensen, 1985).

When the problem is known, but the solution is unknown (square B in figure 2.6), innovation is needed (K. S. Christensen, 1985) She encourages inventiveness and creative sensitivity to varying constraints rather than rigid setting up of standards for efficiency and effectiveness. This situation can either be approached through trial-and-error, “muddling through” (Lindblom, 1959), or as a more conscious and

systematic effort and search of knowledge and solutions. Either way, the planning process becomes a learning process.

When the means and solutions are known, but there is disagreement about the goal (square c), there is need for bargaining (K. S. Christensen, 1985). Here the planners' role is to encourage and set the stage for communication. Emphasis should be on identifying different stakeholder interests, take the point of view of all parties, and negotiate the goals. In such a process, it is important to accommodate multiple preferences and interests of the stakeholders. Maybe several goals can be achieved at the same time.

There may also be situations where goals are unarticulated or multiple and no knowledge of how to achieve them (square D). This seems chaotic, but is nevertheless a common situation (K. S. Christensen, 1985). Such a situation *"becomes a continuous process of action and reaction without direction"*, and here the planner needs to actively formulate the problem in order to help identify and (re-)articulate what the goal is. This implies an attempt to move towards a situation in the B square of the figure.

The four different combinations of known/unknown means and ends are presented in figure 2.6, building on Christensen (1985). In each square is summarized the type of action needed to address the situation. The figure is a prototype and real-life situation are of course rarely so simple. The value of the model is that it points towards different types of responses to the situations.

		GOAL	
		agreed	not agreed
MEANS	known	A <u>Programming</u> - Predictability - Equity - Accountability - Efficiency - Effectiveness - Administration	C <u>Bargaining</u> - Accommodation of multiple preferences - Advocate - Facilitate - Mediate
	unknown	B <u>Experimentation</u> - Innovation - Responsiveness - Research - Experiment - Adjust - Be pragmatic	D <u>Chaos</u> - Discovery or creation of order - Find problem

Figure 2.6 Different combinations of uncertainty regarding goals and means requires different planning strategies and approaches (Christensen, 1985)

In relation to the process of developing circular business models, this perspective on planning processes can be used to understand, that the process may not necessarily begin with a carefully considered strategy and clear, spectacular goals to move from one type of linear business towards another clearly defined type of circular business model. Rather it may be a trial-and-error process, with smaller decisions being made gradually. Moreover, the small daily decisions made by the employees develop in practice the business model and depends on these people's knowledge, skills and values and how they imagine the final goal. The process thus becomes a learning process, like Christensen (1985) writes. In addition to this, the need for stakeholder collaboration in circular business models adds the challenge of balancing, negotiating and bargaining external interests too. Thus, the need for bargaining and negotiating with stakeholders is vital in the development of circular systems. In summary, the process may not be rational, and the final result may not have been clearly defined as the goal prior to the process.

2.5.4. INNOVATION JOURNEY

Due to the fact that uncertainties about means and ends seem to characterize circular business model innovation, and that one way to approach the uncertainty about means (and to some extent also goals) is suggested to be experimentation and innovation, I will end this chapter by presenting how innovation processes can be understood. This will be used to understand how the circular business models in AVV were in practice decided upon, developed and implemented.

Circular business model innovation is in present study seen as innovations to the extent that they are a “practice [...] perceived as new by an individual or unit of adoption” (Rogers 2010). In addition to this definition, van de Ven et al. (1999), who have worked with innovation processes in complex contexts and organizational settings, define some basic characteristics of innovation processes. Firstly, innovations consists of purposeful and concentrated efforts to develop and implement a novel idea. Secondly, this idea is characterized by a high degree of uncertainty (technical, organizational and/or market wise). Thirdly, the innovation process entails a collective effort over a considerable period. Finally, the innovation process requires greater resources than the people conducting the innovation actually have (van de Ven et al., 1999).

One of van de Ven et al.’s (1999) main points was that innovation processes often unfold in a less orderly way, than for instance the linear step-by-step approach suggested to be possible by Kraaijenhagen et al. (2016). Moreover, there may not necessarily be a fixes solution that is pursued from the beginning. They write that the process of innovation *“does not unfold in a simple linear sequence of stages and sub stages. Instead, it proliferates into complex bundles of innovation ideas, and divergent activities by different organizational units”* (Van de Ven et al., 1999). Non-linearity and non-predictability thus characterize the innovation process, and it is fair to assume that this also accounts to circular business model innovation.

There are however, some common phases of innovation processes. Firstly, there is an **initiation phase**, in which seemingly coincidental events set the stage for innovation (gestation). There may also be shocks or triggers that makes the need for innovation somehow feel urgent. The last part of the initiation phase includes planning and allocation of resources to begin the innovation development (Van de Ven et al., 1999).

After this, there is a **development period**. In this period, numerous ideas and activities are discussed and effectuated. Unanticipated events may affect the process, setbacks may occur, unforeseen need for knowledge and/or resources may arise, and resources and time may (seem to) be limited. It is rarely clear what the final goal will be, and there may not necessarily be aiming for fixed solution from the beginning. This also means that it can be unclear to the involved workers and the

adopter what the aim is. In change processes, such as circular business model innovations and sustainability innovation processes, visions, strategies and goals are emphasized as prerequisites (Kirschherr, 2017; Kraaijenhagen, 2016). Yet, the way decisions in organizations are actually made in practice are rarely as rational as the ideal conception. In the ideal conception of a decision making process, clear and unambiguous goals exists, and all alternative courses of action and their consequences are considered (Kjær and Thanning Vendelø, 2014). The ideal conception presupposes, that decisions are made on a systematic comparison of these consequences, and the process follows a causal chain from problem->decision making->action. Such assumptions about processes are unrealistic (ibid). Kjær and Vendelø (2014) point towards the fact that decision makers, be it CEOs, managers or employees, are limited by their own skills, knowledge, habits, values and imaginations about the goal. Moreover, decision making processes in organizations are often characterized by diverse, conflicting goals, limited information and limited resources. Moreover, there is often changing participants in the process (Van de Ven et al. 1999). Collaborations with external partners, which is emphasized as important to circular economy solutions, additionally influences the innovation process and what decisions are made (Van de Ven et al. 1999) by adding the challenge of balancing and negotiating external interests too. Just as the conception about the rational economic man is insufficient, the conception about the rational administrative man/company is also insufficient. Decisions are made “*in a complex interweaving of affective and cognitive processes*” (March & Simon, 1958). Decisions making processes are often non-analytic and oriented towards the means rather than the final goals. Thus, the result is not great spectacular decisions, but gradual changes. One can say that the decision makers huddles through the process (Kjær & Vendelø, 2014).

In relation to the process of developing circular business models, this perspective on how decision are made and innovation processes occur in practice can be used to understand, that the process may not necessarily begin with a carefully considered strategy and clear, spectacular goals to move from one type of linear business towards another clearly defined type of circular business model. Rather it may be a trial-and-error process, with smaller decisions being made gradually, and the outcome of an innovation process is unpredictable.

In the final phase, the implementation phase/termination period, the innovation is adjusted to the local situation. Through the development period, the “new” is linked with the “old”, and the innovation stops when the new solution is implemented (Van de Ven et al. 1999).

CHAPTER 3. METHODOLOGY AND RESEARCH DESIGN

In this chapter, I will describe and discuss the methods and the methodological approaches that I have used to research and investigate the research topic. I will do this in order to create transparency about how and why I have made the choices concerning materials and methods, what limitations this might have, and how I have derived to my results. Apart from providing clarity to the reader, this is also made in order to be able to assess the validity of the results.

An industrial PhD study gives rise to a number of questions and considerations regarding how to make scientific research in close collaboration with an industrial partner. The aim of making contextually localized research is – apart from the academic goal of scientific knowledge creation - to contribute to the learning and development in AVV, potentially leading to business development and/or commercial gains for the company (Innovation Fund Denmark, 2017). In an industrial PhD or in similar societally engaged research studies, the pursuit of these two overall goals are in practice intertwined, interdependent and happen concurrently. This interdependent relationship between academic research objectives and business developing aims holds possibilities, but also challenges. For this reason, I have set aside a significant part of this chapter to this discussion.

3.1. DISCIPLINARY PERSPECTIVES

The research presented in this thesis is placed within the broader disciplinary field of sustainability science. Sustainability challenges are complex, and therefor often call for a multidisciplinary approach, where knowledge from different academic fields are combined (Schaltegger, Beckmann, & Hansen, 2013). Furthermore, research in practical sustainability challenges aim at creating and applying knowledge that can support decision making for a sustainable development. In order to increase the research's relevance to practice, the knowledge to be coproduced in close cooperation between researchers and practitioners (Clark & Dickson, 2003). In other words, a transdisciplinary approach (i.e. collaboration between several sectors) can be fruitful. Levin (1999) argues that knowledge with relevance to societal changes can advantageously be developed within practical experiments and projects, and this invites to participation and accountability (Nielsen & Nielsen, 2010). The research conducted for present thesis has been multidisciplinary, i.e. drawing on scientific fields such as industrial ecology, sociology, planning and management, but most distinctively, it has been interdisciplinary through its embeddedness within and close collaboration with an industrial organization, i.e. AVV.

3.2. DOING RESEARCH ENGAGED WITH AN ORGANISATION

Research in sustainability challenges require close collaboration with practice, in my case the collaboration was with AVV. As a researcher engaged in and financed by a company, questions regarding my positioning as a researcher, my role in the company and in the science community, and how to conduct research, have been present and essential. The motivational factors for a company to engage in a research project could be as stated on the innovation fund's homepage: that the research project can *"create results that can lead to commercial gain"* (Innovation Fund Denmark, 2017). A PhD project situated in a commercial company is thus not only to make scientific results but the *"results are applied in an enterprise setting"* (Innovation Fund Denmark, 2017). These dual aims pose some challenges for the researcher and gives rise to questions of how I as a researcher can make research that simultaneously had scientific value and relevance to the company. What are important problems to investigate in this particular practical setting? And who are to define these questions, and how should they be investigated? In addition to this, is also questions concerning what a good scientific contribution to the field is. Is it even possible to make *"good science"* from the outset of a company? And isn't this kind of research just a consultancy task in disguise? These questions and many similar have been rummaging throughout all of my time as an industrial PhD student. To address this, I attended a PhD course about the challenges and possibilities of research engaging with society. Here, I learned about the concept of mode 1, 2 and 3 research, and this gave me a language to analyze and reflect upon my own practice and made me conscious about the importance of making deliberate and conscious choices regarding my positioning as a researcher. In the following, I will shortly present the three modes of research in order to support my further reflections on what choices I made concerning my own positioning throughout the PhD project.

3.2.1. THREE DIFFERENT MODES OF RESEARCH AND ITS RELEVANCE TO STRATEGIC POSITIONING OF THE RESEARCH

Mode 1 is the classic researcher who works independently from societal partners. When working from a mode 1 position, the researcher autonomously defines what research questions are relevant and how they should be investigated. As such, the researcher does not necessarily take into account the relevance and applicability of his research to the society. The mode 1 risks to be perceived as sitting in an ivory tower if not careful about communication (Gibbons et al., 1994). From this mode, what counts as good science is determined by a well-established disciplinary structure of science (Gibbons, 1997). Mode 1 is most often disciplinary. Mode 2 on the other hand is interdisciplinary.

Mode 2 was developed to describe a different type of research, in which the researcher works in close collaboration with non-academic organizations during the

process of knowledge production. Some mode 2 thinking developers, Gibbons and Nowotny, argue for the need to move the focus of empirical research into action- and problem-solving-oriented, local contexts (Nielsen & Nielsen, 2010). They argue that the ambition to establish ever valid theories and concepts in the complex societies of today characterized by high degrees of uncertainty, will lead to theory creations with so many reservations and restrictions that they risk ending up losing their relevance and clarity (Nielsen & Nielsen, 2010). For this reason, they argue that concepts and theories should be reduced to guidelines for context specific studies. In mode 2, the relevant research questions thus take their point of departure in practice, and they are defined in dialogue between the researcher and the practitioners, such as a company. When this type of research is financed by an industry partner the research is related to a certain demand from the industry partner (Kurek, Geurts, & Roosendaal, 2007). The researcher is thus highly dependent on the industry partner and is socially accountable to them. Mode 2 is validated by its relevance to practice rather than by the disciplinary structure of science.

Kurek et al. (2007) argues that mode 2 research can be too steered by the non-academic organizations' requests for particular research results. Similarly, Huff (2000) criticizes mode 2 for *"moving away from science and technology into management"*. For this reason, they add a third mode to Gibbons and Nowotny's original framework. **Mode 3** is characterized by *"The two parties, the researcher and the environment, are keen on establishing this relationship; the researcher because his research will be funded and his research interests will be realized, the societal environment because scientific results will be applicable..."* (Kurek et al., 2007). The research in mode 3 is oriented towards society, but the research entrepreneur is fully intertwined with his societal environment but also strategically interdependent of it. This means that the researcher has a higher degree of autonomy than in mode 2. The autonomy is expressed in decisions regarding research goals, potential collaborators, methodological approaches etc. Moreover, as the researcher does not simply supply on a demand for research, he influences and directs his environment by creating demand for his scientific products (Kurek et al., 2007). Mode 3 research is sometimes called "change-oriented research" (Jamison (2001, 2008)). Jamison defines change-oriented research as problem-based with the aim *"to intervene creatively and constructively in an ongoing social or political process: to contribute to change. Rather than the traditional notion of enlightenment, by which is usually meant that the role of the scientist is to provide insights for the broader society, derived from a "disinterested" pursuit of the truth, change-oriented research is about empowerment, where the researcher applies knowledge gained from experience to processes of social learning, carried out together with those being "studied" (Jamison, 2010: 9).*

Within mode 3 research, or action research, the researcher is involved in change processes in the field of research. This means that the researcher and the practitioners acquire some common experiences. The core of mode 3 is the radically

engaging relation between the researcher and the practitioners in the field (Nielsen & Nielsen, 2010).

The distinctive features of three different research modes are presented in table 3.1.

Table 3.1 Differences between mode 1, 2 and 3 research. A continuum of modes of strategic positioning (Based on (Gibbons, 1997; Gibbons et al., 1994; Kurek, Geurts, & Roosendaal, 2007; Nowotny, Gibbons, & Scott, 2001)

	Mode 1 “Ivory tower”	Mode 2 “Strategic research”	Mode 3 “Research entrepreneur”
Who defines what problems are relevant to investigate?	Problems set and solved in the context of academic interests	Problems emanate from practice. Knowledge is worked out in a context of application Needs that is explicitly expressed by the partner	Researcher can autonomously determine directions of research, but in collaboration with partner/society
Disciplinary approach	Disciplinary	Inter – and/or transdisciplinary	Inter – and/or transdisciplinary

Demand and supply of research	No relationship between researcher and his societal environment. Hence, no need to take into account societal needs and demands when setting research goals. Results of research not necessarily meant to be of societal relevance.	The societal environment directs the researcher The researcher is “context-sensitive” Knowledge is produced in the context of application Research outsourced by financial partners The researcher does not influence his societal environment in creating demand for his scientific products, but supplies in reaction to demand	Researcher is fully intertwined with his societal environment yet strategically interdependent of it. Influences decision making in societal environment Creates demands for research
Dependency/a utonomy	Researcher is independent and Autonomous	Researcher is financed by external partner, thus Dependent	Researcher shares resources with partner (interdependent), thus Autonomous
Skills	Homogeneity of skills	Heterogeneity and organizational diversity	Heterogeneity and organizational diversity
Who does the research serve?	Serves self/academia	Serves the financing organization	Serves people and/or the environment

Such strategic positioning is not always conscious and explicit (Kurek, 2007). In practice, I have worked within all three modes, sometimes consciously and sometimes rather unconsciously. In the beginning of the PhD project, I was aware that there would be scientific implications of working so closely with a company,

but I was not conscious about how to work with it strategically. In principle, I have been dependent on the funding from AVV, which in theory should position me within mode 2 or 3. Principally, the collaboration would only be maintained for the three years that a PhD project is expected to last, if the collaboration resulted in added value for all partners, i.e. AVV, Aalborg University and me. This view I held much in the beginning of the project, before I got to learn AVV better and develop trust in the relationship. I felt highly obligated and responsible to perform research that AVV would be able to apply in practice, as it was specifically intended by the Industrial PhD program (Innovation Fund Denmark, 2017). The consequence of my view on the relationship and feeling an obligation to provide applicable results was that I in the beginning compromised the research on behalf of engagement in the daily operations and practices in AVV. Though not producing much research in the beginning, I gained many insights into the waste sector that I have subsequently been able to use as background understandings and knowledge for my later work.

3.2.1.1 Defining research questions – in dialogue (Mode 3)

One of the differences among the three research modes concerns who defines what research questions are relevant. Throughout my project, I experienced high autonomy in defining research questions, but I also continuously felt an obligation to bring about useful and applicable results for AVV. For this reason, I requested wishes for research topics from AVV. In dialogue, we negotiated the research themes. The main research question

How can innovative, local, circular economy solutions and business models for waste reduction and reuse be developed and established in a municipal solid waste management company (AVV) in co-existence with traditional waste management solutions?

could in principle have been investigated from the distanced mode 1 research, thus aiming at theoretical and context independent results. But for AVV, the motivation for engaging in the research project was to engage in a learning process and acquire knowledge and competences to experiment with circular economy solutions. For this reason, the sub-questions and the research methods were chosen in an ongoing dialogue between AVV, my supervisor and me.

3.2.1.2 Shared learning and added value through mode 3 research

The studies presented in the articles build on this engaging collaboration, but to various degrees. For instance, article A (Zacho & Mosgaard, 2016) is a literature review, which means that the actual conduction of the research could have been made from a mode 1 position. However, being located in AVV, made it possible for me to discuss waste prevention with my colleagues at AVV, and this contributed to my understanding and thus affected the focus in the article (prevention from a local

perspective). Conducting the research for this review article (A) was not only contributing to my learning, but had also impact on the learnings in the innovation department in AVV. Firstly, during this sub-study, we discussed the definitions of the waste hierarchy, and subsequently began using the terms correctly and consistently. For instance, the terms “reuse” and “recycling” had previously been used interchangeably, and “minimization” had been used as both meaning “sorting for recycling” and as synonymously to “prevention”. Secondly, during this process, the waste hierarchy became a common cognitive and analytical model among the employees in the innovation department, which is still used today. Thirdly, through this study, waste prevention was put on the agenda in AVV as something different than sorting for recycling, which had been the focus on the Nulskruld projects¹: Following the review article (A) on prevention, a practical project on prevention of paper waste was initiated in AVV. Due to time restrictions and my maternity leave, I did not follow this project and it is not included in present thesis. However, it is an example of how the topics of the PhD project generated learning and new projects in AVV thus adding value, but in a different way than initially anticipated. Conclusively, in sub-question one I positioned myself as a researcher outside AVV, but providing input to them, which generated learning and new projects.

Opposite to Article A, Article D, i.e. the study on practices in the recycling centers, was a result of more broad submerging into the practical daily life among the employees in AVV. The research question was defined in collaboration with the management in AVV, and compared to article A, there was an explicit demand for this study. In this regard, the definition of the research question was like a mode 2 approach. Moreover, I collected all the empirical data for this article within AVV, by participating in the working practices (this will be described in more detail in section 3.4.3). This sub-study resulted in the development of new practical management tools in AVV, and the knowledge was thus produced in the context of application (mode 2).

With regards to following and analyzing the process of developing circular business models in AVV, my positioning has changed over the years. In the beginning, I was fully submerged into the practice, actively engaging, for instance organizing meetings, taking initiatives and making contacts with potential collaborative stakeholders. Though there are benefits of such an approach, I also experienced difficulty in separating my role as a researcher from that of an organizer. For this reason, I pulled back and for the last half of the PhD project I mainly observed, studied, discussed and reflected with my fellow colleagues in AVV rather than actively engaging as in initiating and operating experiments. In some companies, this may have hindered to development process, but in AVV they kept experimenting with or without my active engagement in the practical organization.

¹ Nulskruld was a citizen awareness project, that AVV had initiated and run in 2013. It is presented in more detail in chapter 7.

For this reason, I found that what would be of most value to AVV and to the research process would be to approach it from a mode 3 position.

In the latter half part of the project, I began to fully realize that the benefit for AVV might not be so much in the applicable tools developed in the study, but more resided in the shared learning that was the outcome of the continuous and iterative processes of dialogues, and shared reflections. I find it difficult to pinpoint exactly where and how I contributed to the processes of developing circular business models in AVV. It is the daily presence, the continuous iterative process of discussing and reflecting on the practices and actions in AVV together with colleagues in AVV, reading literature, discussing and reflecting with colleagues at the university, and then going back again, that I believe gives the added value of research to an organization.

3.2.1.3 Risks and challenges associated with research modes 2 and 3, and collaborating closely with a non-academic organisation

Collaborating with external industry partners in the research process does not come without risks. One risk is that the researcher becomes too involved in the specific contextual setting, resulting in a lack of distance to maintain a critical reflection (Kørnøv, 2011), and that the strong involvement can compromise the ability to stay critical as a researcher. During my time in AVV, I have experienced a propensity to adopt some of AVVs perspectives and interests and direct my research towards a confirmation of these. This was for instance the case in the questions regarding liberalization of the sector. If a liberalization of the waste sector is politically adopted, it would have implications for AVV. Being situated in AVV, it was difficult to observe this debate without taking sides, i.e. without adopting the view that waste management should remain a public task. The same was the case with the municipalities' rights to operate reuse shops. This has been a political debate, and still is despite the Appeal Board's decision (Ankestyrelsen, 2017) that municipalities are allowed to operate reuse shops. If they had decided the opposite, AVV would have had to close the reuse shop and the prepare-for-reuse activities. This would have affected the foundation for the PhD project. Thus, I had an interest in positioning my views on the side of AVV in this matter, but this should not be a hinder for other perspectives. I was aware of the risks that working so closely with an industry partners might challenge my ability to stay critical. Maintaining a close collaboration with my supervisor and university colleagues helped me remain conscious of when I tended to adopt AVVs interests as academic objectives. Nevertheless, there may be views, values and opinions that I have unconsciously adopted from AVV, which may affect my research.

In relation to this, Kørnøv et al. (2011) found nuances in the way mode 3 research is conducted in practice, and that mode 3 research can be conducted in various ways depending on the specific context, personal preferences, timing, resources etc. In

practice, mode 3 positioned researchers can have different levels of involvement. This includes different levels at which the researcher is personally involved in the study field; how much the researcher identifies with the study field at a personal level; and different levels of critical participation in the processes studied (Jamison, 2010).

Another risk mentioned by Kørnøv et al. (2011) relates to the unpredictability in the research process and thereby the actual possibilities of creating synergies between practice and research. Based on own experiences, I would add that the unpredictability and uncertainty about what the future will bring and what is going to happen in the organization makes it difficult to plan and design a systematic research process. For this reason, this type of research requires a rather agile approach in which research focus, goals, questions and methods can continuously be adjusted (Engwall, 2002). As an example, in the beginning of my PhD (Dec. 2013), AVV had not decided to make a workshop. There were fluffy discussions about repair, upcycling and the like, but it was not so, that AVV set a specific target, for instance that in 2017 they would operate a workshop, this being a process that I as a researcher could follow and participate in. There were vague ideas, discussions and indefinite plans; meetings with a variety of people and organizations; a grabbing of opportunities; participations in various conferences and meetings, etc. Neither the process nor the outcome was planned. It was highly experimental and this affected the research process. Much of the actual research has in practice been to be present in AVV, participate in meetings, observe, take notes in a logbook, discuss, reflect, and then at the end sum it all up retrospectively. During this process, it was difficult to know whether this or that meeting or discussion would be of relevance to the research. I will elaborate further the more practical research methods that I applied after a short introduction to the mainly qualitative approach that I have taken.

3.3. CASE STUDY

AVV is one municipal waste management company among many local waste authorities in Denmark. Much of the research in present thesis is conducted within and about AVV, and large parts of the study are thus based on case study research. Case studies usually investigate social phenomena, which are context dependent (Flyvbjerg, 2001; Neergaard, 2007). Case studies are suitable for exemplifying and explaining how and why certain events take place or situations arise (Yin, 1989). In present study, the case of the processes that has taken place in AVV can be used to gain deeper insights into and develop understandings what circular economy in a waste management company actually is. Thereby, I use the case study method to test, challenge and contribute to existing theory, i.e. the concept of the Circular Economy. Since it is the first of its kind (a waste management company developing their business from the outset of CE), the case study is also explorative.

Usually cases are carefully selected in order for the research results to serve a specific purpose. It would be wrong to say that AVV was selected on the basis of considerations regarding its ability as a case to obtain a particular type of information. The arrangement of the research study was made prior to any considerations regarding AVVs suitability as a case (in reality, isn't many cases in research "selected" because the researcher grabbed an opportunity when it presented itself?). Even though AVV was not carefully selected as a case based on specific criteria, it is worthwhile to reflect on what type of case it is in the context of experimentation with and implementation of circular economy inspired solutions. In the following, I will argue why AVV is not just a random case, but also a case that with high probability would have been selected for an investigation of implementation of circular economy. In order for case selection to be meaningful, it needs to be purposive, i.e. case and study purpose must match (Neergaard, 2007). Moreover, it is necessary to reflect on what type of case AVV is in this context in order to be able to assess what we can deduce as scientific knowledge from the results and what limitations AVV as a case has.

3.3.1. CASE SELECTION CRITERIA

Cases can be selected based on different criteria and purposes. In table 3.2, different types of cases and their purpose are presented. I exclude the types of cases that require more than one case. For instance, cases with maximum-variation requires two cases to be compared. As I have only worked with one case, I only include case types that can explain single cases. Single cases are chosen for their ability to maximize the usefulness of information (Flyvbjerg, 2006).

Table 3.2 Cases that describe either something unique or something typical, and thereby are able to maximize the information obtained from the case (based on Flyvbjerg, 2001; Neergaard, 2007)

Selection strategy	Purpose
Extreme/deviant	Learning on the basis of very unusual manifestations of the studied phenomenon
Typical	Emphasizes what is normal and average
Revealing	Illustrates common problems
Intensity	Information rich cases, that manifests the phenomenon intensely, but not extremely
Critical	Allows logic deduction and generalization, and the use of information applied on other cases
Politically important	Attracts wanted attention or Avoids unwanted attention

3.3.2. THE NARRATIVES OF A CASE STUDY

Case studies are often presented in a narrative form. In such narratives, it is necessary to make room for the details and the complexities that are present in the case. For this reason, summarizing the narratives into scientific formulae or depriving them their details is both difficult and undesirable (Flyvbjerg, 2006).

In the writing of the case study narrative, I do, as suggested by Flyvbjerg (2006) seek to avoid the role of the all-knowing narrator. I present the processes in AVV as I have experienced them based on the data I have collected, well-knowing that this may not be the entire truth.

A detailed case narrative that reveals complexities, contradictions, and diversity is in itself a result (Flyvbjerg, 2006). What the narrative provides is a greater sensitivity to the questions and problems related to the phenomenon that is of interest in the case (Flyvbjerg, 2006).

The parts of this PhD thesis in which internal processes in AVV comprise the main focus of interest, I present as a case study narrative. More specifically, this method of description and analysis is applied in the sections that follow each scientific article and that has specific focus on the learning and development processes in AVV. In the research articles, I have not applied a narrating approach as these sub-

studies mainly build on other more specific data collection methods (described later in this chapter).

3.3.3. EVALUATION CRITERIA

The case study's status as a scientific method has been debated due to misunderstandings regarding theory, reliability and validity (Flyvbjerg, 2006). These debates include some of the same concerns as the concerns related to social and transdisciplinary science projects, to action research, and to mode 2 and 3 research. The close interaction with practice has epistemological implications. The knowledge produced becomes highly context dependent, and this raises the question of its scientific value. As case studies and action research/mode 3 research involve actors in local settings, this type of research is per definition contextualized (Nielsen & Nielsen, 2010). But the topic of Circular Economy needs to be investigated in practice. When taking a micro or meso perspective on the circular economy, it will inevitably involve companies and their customers, suppliers and other stakeholders. The enablers of a circular economy are organizations (Kirschherr, Reike, & Hekkert, 2017), and for this reason insights from a practical case study can reveal much more detailed information and contribute to a deeper understanding than longitudinal and quantitative studies following a natural science logic. Moreover, it would be an impossible task to produce explanatory and predictive theory based on this one project. Hence, that is not the aim of this study. This does however not mean that the project does not have scientific value. This type of study aims to make a reflexive analysis and discussion of the complexities, contradictions, dilemmas, values and interests, challenges and opportunities in relation to implementing circular economy in a company. Such reflexive analyses cannot be reduced to nice scientific formulas and general theories (Flyvbjerg, 2006). Yet, such reflexive analysis and discussions are the prerequisites for a sustainable development in society. In this particular case, it is the prerequisites for AVV to transition towards a circular economy in an enlightened and meaningful way.

3.3.4. AVV AS A CASE

How I work with AVV as a case differs in the individual chapters. This is because the more specific purposes of each article/chapter and the overall thesis research question differ. There are, however, some distinctive features of AVV that I would like to emphasize as being determining for what knowledge can be produced from the case.

Firstly, AVV is famous in the waste sector for its reuse shop. They were, if not the first, then among the first municipal waste companies to organize reuse. This means that the starting point for developing circular solutions is different than in waste management companies in general, who have no reuse shop and to whom a reuse shop might even seem unthinkable.

Secondly, the culture in AVV is characterized by curiosity and playfulness, and this supports the possibilities for experimentation. Experiments and innovative projects have been undertaken in AVV since the beginning. The reuse shop is one example, the Nulskruld project is another. A third example, which may in today's standards seem irrelevant, is that AVV was the first waste management company to hire a communication assistant in 2000. At the time, this was unheard, whereas now it is common practice. Likewise, they were the first to hire PhD students. In summary, AVV likes to be the first in class to experiment and take up new trends and technologies. In comparison to other municipal waste management companies, AVV does many things that they are not obliged to do (see also chapter 4, 6 and 7).

Thirdly, AVV also holds some general features that allows for generalization. They operate an incineration plant, recycling centers, and a landfill, and hold monopoly on waste collection from households in their geographical area. They are subjected to the regulation as any other waste management authority. These features are similar to other waste management companies in Denmark.

AVV is thus a common waste management company with a different organizational culture that allows for experimentation. Hence, concerning the overall research questions, I will argue that AVV is an intense case from whose endeavors with circular economy other waste management companies can gain knowledge and learn something from that may be applicable in general. In that sense, it can be used to generalize, but this is not the main aim (as described above). The case is, with regards to the reuse shop, also political, as it attracts attention, initiates political debates and adds fuel to the fire of the disputes about the authorization of municipal waste authorities and their legal rights to prepare waste for reuse.

3.4. QUALITATIVE RESEARCH AND ITS METHODS

As the reader has probably already deduced from the first part of this chapter, this research project mainly takes a qualitative approach. Case studies and Action research can apply both qualitative and quantitative inquiry methods for establishment of new knowledge in a field. I have included some quantitative data, but the study is mainly qualitative.

The main interest of qualitative research is to investigate and analyze meanings and interpretations (Järvinen & Mik-Meyer, 2017). In qualitative research approaches, the researcher aims to see the reality from the subjects' perspective and try to understand the meaning that certain phenomena has for the involved (Brinkmann & Tanggaard, 2010). It aims not just to describe certain characteristics of people or organizations from the inside, but also to analyze how specific characteristics are created and what they mean to lives of the participants (Järvinen & Mik-Meyer, 2017). The focus of qualitative research is thus on the processes (not necessarily as a

line of stages or causal relations over time) but as mutually affecting mechanisms between interacting people and their environment (Järvinen & Mik-Meyer, 2017).

Qualitative research focusses on the context of the studied phenomena. We cannot isolate phenomena from their context. This also means that the aim is not to generalize across different contexts, but to study the phenomenon as anchored in, and made possible by, a specific space, time and cultural context (Järvinen & Mik-Meyer, 2017), as also described in the section 3.3. about case studies.

I have mainly taken an inductive approach. At least more often inductive than deductive, i.e. where one develops understandings, concepts, and perhaps even theory on the basis of empirical material, rather than collect data and test beforehand given hypothesis and models (Järvinen & Mik-Meyer, 2017). In practice, however, I have often worked abductively. This implies that I have searched in theories to explain the empirical data that I found. Abduction is an analytical approach in which one shifts between empirically driven interpretations and concept development anchored in theory (ibid). The analysis then becomes a dialogue between theory and empirical data, so that the empirical data influences the choice of theory, at the same time as the theory helps to interpret the empirical findings and put them into perspective. However, there is consensus among qualitative researchers that analysis should not be too much driven by theories. Theoretical knowledge and preunderstandings can be used as tools to investigate and construct new understandings with an outset in empirical data (Järvinen & Mik-Meyer, 2017).

3.4.1. DATA COLLECTION

In this section, I will describe the data collection methods that I have used in order to clarify how the results in each sub-study have been derived. This consists of a combination of four qualitative data collection methods: document review, interviews, observation and participant observation. Additionally, I have used quantitative data for the study in Article C. Using multiple methods improves the construct validity of a case study by increasing their robustness (Yin, 2014). In the end of the chapter, table 3.3. presents an overview of which research methods have been used in which chapters of this thesis.

3.4.2. DOCUMENT REVIEW AND ANALYSIS

Lynggaard writes: *“It is almost impossible to imagine empirical investigations that do not in one way or the other include documents”* (Lynggaard, 2010: 137). Different types of a multitude of documents have been used as both background material and primary data for present study. Lynggaard (2010) distinguishes between primary, secondary and tertiary documents. The primary documents are those that are not available to everyone. In this thesis, this includes AVV internal documents, such as strategy documents, historical documents, minutes from

meetings, etc. The secondary documents are those that are available to the public but not necessarily of interest to all. This could be governmental documents or paper articles. Examples of secondary documents used in this thesis are policy papers, regulations, municipal waste management plans, and AVV's environmental management report (which is not confidential and can be read by everyone visiting the home page). The tertiary documents are documents in which certain events or situations have been processed and analyzed. This includes scientific research articles.

Throughout the study, I have collected, reviewed and analyzed documents. Firstly, literature reviews of scientific studies (tertiary documents) have been made for setting the stage for the overall thesis, but also for defining the direction of research within each of the articles. Likewise, the contemporary waste regulations have been used for setting the stage, defining relevant research questions, and used as the background upon which the findings of the thesis can be used for recommendations for future regulations. The internal AVV documents have been used for describing the contextual elements of AVV as a case, but also as data for the analysis in Article C and D.

3.4.3. PARTICIPATORY OBSERVATION AND ETHNOGRAPHIC FIELD STUDY METHODS

The ethnographic fieldwork and observation are ideal methods for studying what goes on in organization and among people, for whom certain actions and perceptions seem so natural and taken for granted that they might not even be able to articulate them (Hastup, 2010). As I spent much of my time in an open office in AVV, participating in the daily operations, meetings etc., I gained much insight simply from being present. This type of observations, Bryman (2012) calls unstructured observation. The unstructured observations and participation also included meetings and engagement in reflexive discussions with the practitioners at AVV. This provided me with understanding of key issues related to waste management in general and with respect to circular economy; and insights and understanding of values, positions and perceptions of different actors in AVV with regards to the theme of this study.

Observations and participatory observations are ethnographic field study methods and this type of field study is not particularly well suited for collecting data in the conventional understanding of "data". Rather, field studies are unrivalled when it comes to acquiring knowledge about what goes on between people or in an organization (Hastup, 2010). Such knowledge acquisition is never objective, but will inevitably be biased by the prejudices that the researcher observes them through (ibid). I come with my prejudices, that are formed by my educational background, my personal values, my political orientation etc. and this inevitably affects how I perceive what I observe.

When participating it is impossible not to affect the objects studies, while studying. For instance, after having been present in AVV, asking questions, and discussing with my colleagues, new lines of thoughts, new understandings emerge among them and in me (Hastup, 2010). Yet, as described in the section about the different modes of research, such mutual learning that took place for me and for the practitioners in AVV was exactly an intended part of the study. This also implies that while I as a researcher aims to understand my study object, it changes its form (ibid). A quite practical consequence of this is, that I in this thesis have chosen to present AVV as it was in the beginning of 2014 in order to make clear to the reader how AVV has changed during those four years.

A field is always complex, and for this reason it is necessary to define an analytical object (Hastup, 2010). The analytical object in this PhD study is *the process that takes/has taken place in AVV to develop circular business models and solutions*.

Throughout the project period, I noted my observations and immediate thoughts in a logbook. These notes comprise a large part of the data material for the case study narrative of the processes in AVV.

The ethnographic field study methods of participatory observation were applied throughout the project period, but in Article D I used this method with another analytical object and in another contextual setting, i.e. the recycling centers. Here the analytical object was the working practices of the employees at the recycling center. The research methodology for this study is more comprehensively elaborated in the research Article D.

3.4.4. INTERVIEWS

Steiner Kvale has defined the qualitative research interview as ” *an interview, whose purpose is to gather descriptions of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena*” (Kvale, 1983, p. 174). I made many interviews during the PhD project, but only the interviews for the study of the working practices (Article D) applied this definition to its full extent. In many other interviews, the aim was not so much to get insight into the life-world of the interviewee and fully understand his or her perception of something. Many interviews aimed at acquiring insight into the professional positioning of the interviewees on a certain subject, such as the stakeholder analysis in Article B about WEEE, or professional motivations for engaging in circular economy initiatives, such as interviews with the CEO; or acquiring information about the historic development of the company AVV.

More specifically, I made both formal and less formal semi-structured interviews with AVVs CEO, the innovation manager, the environmental manager, the manager of the recycling centers, the manager of the reuse shop and other eleven employees.

The interview method is not a neutral technique to acquire unaffected answers from the respondents (Holstein & Gubrium, 2003). Rather, an interview is an active interaction between people, which leads to socially negotiated, contextualized answers (Fontana & Frey, 2005). More specifically, this means that the questions that I as a researcher ask, and the way I ask them, co-construct certain answers.

The purpose of the interviews differed. Sometimes they were purely phenomenological, i.e. aimed to precisely describe how certain phenomena were experienced by the respondents (Tinggaard & Brinkmann, 2010). Examples are the interviews for the Articles B and D, in which I aimed to come as close to the respondents' experiences and understandings that I could describe them. In other interviews the aim was not only to understand how the respondent experienced and perceived something, but also to use the interview situation to co-construct new understandings together with the respondent, i.e. to generate aspects that did not exist in the respondents' perception before the interview (Kvale & Brinkmann, 2009).

An example of the latter is the interviews I made with the reuse shop manager. She told me about her experiences with developing the workshop, and I asked her questions based on concepts like sustainability, circular economy and the business model canvas. Together we co-created a new understanding of the process, which led to an increased awareness of the learning process that AVV had been through. These interviews were more informal and loosely structured, and the relation was more symmetrical than in the phenomenological interviews. In these interviews, we (the respondent and I) had a common aim of achieving a shared understanding, and maybe generate new ideas, whereas the relation in the phenomenological interviews was more asymmetrical; I asked and received and the respondent answered and gave.

3.4.4.1 Semi-structured and unstructured interviews

Many of the interviews resemble the type of interviews conducted in classical ethnographic or anthropological field studies. This type of interviews is often informal conversations with participants in the field that sometimes even stretches over several day (Fontana & Prokos, 2007). One of the great advantages with this type of interviews is that they can be conducted whenever a situation arises where the respondent has something to tell (Tinggaard & Brinkmann, 2010). In the beginning of my studies, I did not realize that this was an actual research method, so I planned more structured interviews in order to make my colleagues repeat something that we had previously talked about in an informal setting. I rarely succeeded with this strategy, maybe because my colleagues found it odd to reconstruct an earlier conversation. Therefore, I chose to pursue the strategy of field study interviews, so that I could grab statements, experiences, and elements of discussions when they occurred. The downside to this strategy was that these

interviews were rarely recorded and could thus not be transcribed. Instead I had to rely on my written notes as data material for later. The thesis chapters that contain descriptions based on such unstructured interviews have been read and validated by the people whose stories, experiences and understandings are the main source of evidence. This particularly applies to the sections about the development processes in AVV (chapter 4, section 5.3, 6.3, and 7.2).

In addition to the rather unstructured, informal ethnographic field study interviews, I also conducted semi-structured interviews. In this type of interview, I had a clearer aim of what I wished to gain from the interview. This was the case in Article D, in which I aimed at understanding the work practices of the employees at the recycling centers. I carefully planned these interviews with interview guides based on the aim and the theory of social practice. I recorded and transcribed the interviews, and systematically coded and analyzed them. This process was thus quite different from the research based on the ethnographic interviews, but however more suitable as the aim was to understand their experiences and life-worlds. Moreover, I was not personally acquainted with these respondents like I was with the employees in the innovation department and the management. For this reason, the more planned, formal and semi-structured interview was more suited.

3.4.5. QAUNTITATIVE DATA FROM AVV

Apart from the qualitative data, I have also used quantitative data in one of the studies, i.e. Article C about local value capture. This data encompasses

- weightings of waste collected in AVV
- market prices for waste materials
- economic accounting in AVV

Table 3.3. Data collection methods and theories used in the various chapters of the thesis

Chapter	Empirical data	Theories
1 Introduction	Document review - AVV internal documents - Scientific literature - Policy documents Semistructured and ethnographic interviews (with innovation manager and employees)	
2 Theories and concepts	Document review - Scientific literature - Policy documents	The circular economy
4 AVV and its sustainability journey	Document review - AVV internal documents Ethnographic interviews - CEO - Innovation manager Participatory observation	
5 Prevention review	Document analysis - Scientific literature - Policy documents Participatory observation	
6 Preparation for reuse of WEEE	Document analysis - Scientific literature - Policy documents Semistructured interviews - 21 External - 2 in AVV Study trip - Observations - Interviews	Socio-technical systems Path-dependency and lock-in Planning theory
7 Value creation and	Document analysis	Innovation

capture from preparation for reuse and recycling	- scientific literature - internal AVV Quantitative data - waste weighing data - AVVs economic accounting - LCAs Ethnographic and semistructured interviews - Innovation manager in AVV	journey Planning theory Strategic niche management
8 Work practices	Participatory observation Semi-structured interviews - 12 AVV employees	Social Practice theory
AVV case study narrative	Participatory observation Ethnographic interviews - CEO - Innovation manager - Reuse shop manager - Recycling center manager Document analysis - Mainly internal AVV documents	Circular economy Business models for sustainability Innovation journey Strategic niche management

CHAPTER 4. THE COMPANY AVV AND ITS SUSTAINABILITY JOURNEY

During the time, that present research project was conducted, much has happened in AVV. In 2013, the concept of the circular economy had just emerged on the agenda, and I experienced an excited curiosity and expectations as to what new opportunities this concept might feature. Since then, AVV has experimented with developing the business with a more or less conscious outset in the concepts of circular economy and sustainability. The result being that AVV looks different today, than it did when I initiated my project. In order to capture the process elements of AVVs development and illustrate that waste management has never been static, I will begin with a short historic description of the development of waste management in Denmark with a particular focus on the Hjørring/Brønderslev area. Following this, I will end the descriptive part with a presentation of AVV's business with an outset in the business model canvas presented in chapter 2. In this description, the business model canvas is merely used as a scaffold to provide a snapshot of AVVs business activities. This snapshot of AVV works as a baseline from which the circular business model innovation that has taken place in AVV is to be understood.

4.1. HISTORICAL DEVELOPMENT OF WASTE MANAGEMENT IN AVV

AVV was formed in 1988 as a response to a need to increase the efficiency with which waste was managed in the area. Before that, the general societal changes characterizing the 20th century had left imprints in waste generation and waste management. From a situation where waste was almost non-existent, economic growth and increased levels of consumption in the 19th and 20th centuries had entailed increased generation of waste per capita.

Before 1965, waste was primarily landfilled. The generated waste amounts were much lower then, and the composition of waste was much different from today. As levels of affluence rose during the 1960's so did the amounts of waste generated. In the beginning of the 60's, the need for space for landfills grew. Within the municipality's administration, it was discussed whether to establish controlled composting of the waste or to build an incineration plant. Frequent outbursts of fire in the landfill had inspired this latter idea. At the time, there was only a few incineration plants in Denmark. Simultaneously, district heating was gaining currency, and it was the possibility to link the incineration to the district heating system that made the outcome. The first incineration plant was situated in the city center of Hjørring. Another determining factor for this decision was that the waste composition gradually changed with the introduction of the district heating system;

until then, citizens had heated their homes with wood in stoves, thereby creating a lot of waste ash. Much of the daily discard thus consisted of ash. One of the effects of introducing district heating was that the amount of ash in the daily discard decreased thereby increasing the calorific value of the daily discard.

The next –to our story interesting - thing happened in the beginning of the 1980's. The beginning of the 1980s was marked by high unemployment rates. To accommodate this, the municipalities in Vendsyssel established a project about reuse to create local employment. Nearly 100 unemployed people became occupied in a *Reuse Center*. The reuse center employee's tasks were to drive around and collect recyclable and reusable waste from the households. This included paper, cardboard, glass, metals and reusable things. Households were not equipped with bins for this, and it was voluntary for the citizens to sort their waste. Those who began sorting their waste probably did it out of environmental concerns and/or to support the municipal employment project (interview with innovation manager). The project was thus legitimized partly for its environmental benefits (though not documented) and for the social elements. The collected materials (3000 tons) were sold on the emergent reuse market. Table 4.1 shows an account from 1987 of the collected recyclable waste and the generated income from this. The total amounts of waste collected in 1987 were projected to be 47,000 tons (AVV, 1987). Thus, the materials for reuse and recycling accounted for only about 6 %.

Table 4.1 In the late 1980s, the municipality initiated a project where more than 100 unemployed people were employed with collecting and selling recyclable waste. The collected amounts and the generated income from this are shown in the table (AVV, 1987)

	Tons recyclable waste collected and sold	DKK per ton	Income
Cardboard	800	300	240,000
Paper	400	89	32,000
Newspapers	700	150	105,000
Bottles	200	1500	300,000
Glass (broken)	300	300	90,000
Plastics	200	500	100,000
Metal	600	33	20,000
Reuse items	?	?	200,000
Total	3000		1,087,000

The sales of heat and energy was projected to provide an income on 9,750,000 DKK, whereas the sales of waste materials for reuse and recycling generated 1,087,000 DKK (AVV, 1987). Despite this relatively higher income per tons waste, the large amount of labor needed for the collection made this reuse/recycling collection a less attractive business. It was mainly sustained due to the social effects of activating unemployed people.

4.2. THE FORMATION OF AVV

In 1988-1990, Affaldsselskabet Vendsyssel Vest I/S (AVV) was established. To begin with, it was a merge between the two municipal companies Hjørring Forbrændingsanlæg I/S (Hjørring incineration plant) and Genbrugscenter Vendsyssel Nord (the Reuse center). At the time, the region consisted of six small

municipalities (Brønderslev, Hjørring, Hirtshals, Løkken-Vrå, Pandrup, Sindal), and there was a recognition that waste management was a task more effectively solved in larger units. In the formation report, the purpose of AVV I/S was “to

- *operate the incineration plant*
- *operate a reuse center in order to promote reuse”*

(author’s translation)

(AVV, 1987)

At the time, the words reuse and recycling were used interchangeably. The way the term “reuse” is used in AVVs objects clause it means “reuse” as it is defined in chapter 2. Interestingly, the omission of “recycling” in the clause indicates that either recycling was not perceived to be an integrated part of waste management at the time of formation, or “reuse” was used in the meaning “recycling”. In 1988, AVVs current facilities were built, including the incineration plant, the reuse shop, the office buildings and storage facilities (see picture in figure 4.1).



Figure 4.1 AVVs current facilities were established in 1988. In the back is the incineration plant. In the front is the administration building incl. the reuse shop and halls for preparing waste for reuse and recycling. To the right is the largest of AVVs recycling centers.

Two years later, in 1990, the objects clause was changed to additionally include “*the operation of recycling centers and landfills*” (author’s translation)(AVV & Modtagestation Vendsyssel, 1990). This meant that AVV also officially operated three landfills, and it also entailed the beginning of the recycling centers as we know them today.

4.2.1. REGULATORY PUSHES TO DEVELOP RECYCLING SOLUTIONS

In 1986/87, the first landfill tax was introduced. At first, it was 40 DKK per ton landfilled or incinerated waste. This tax provided the first incentive to develop new solutions for recycling. Employees from AVV visited Odense municipality to see how they had organized what was then called “near-reuse-stations” (translated from the Danish nær-genbrugsstationer), which were manned container sites where citizens could bring and sort their waste into different waste types. At the time, AVV had organized a large number of container sites where citizens could dump their combustible waste and waste for landfill, respectively. After the visit in Odense, AVV reduced the number of container sites significantly, but expanded the number of waste fractions to 10-12 different waste types that could be delivered by the citizens at one site. Moreover, each site was manned by one employee. This was the beginning the recycling centers.

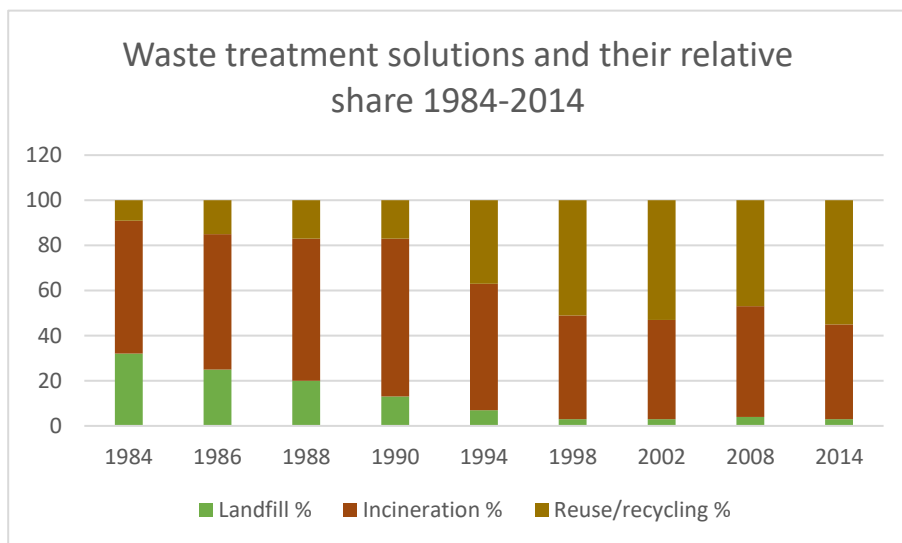


Figure 4.2 The figure shows the dominant waste treatment solutions for the years 1984-2014. From playing a dominant role, landfilling has decreased significantly. Simultaneously, there has been an increase in collection for recycling. Yet, since 2002 there have been no significant changes in the distribution of waste among the solutions landfill, incineration and recycling (reference: internal documents from AVV)

The introduction of the landfill tax had a great impact in moving the waste management up the waste hierarchy. Figure 4.2 shows the development in the share of waste being landfilled, incinerated and reused/recycled in AVVs area. During the 1980's, the first movement up the waste hierarchy happened primarily lead by a decrease in the amounts landfilled and an increase in recycling and incineration. In 1990, the tax increased significantly to 130 DKK per ton. AVV established more recycling centers in this period, and a larger share of the waste (37 %) was collected for recycling. Moreover, in this period affluence increased in Denmark, and the correlation between affluence and waste generation entailed an increase in the amounts of waste. Soon hereafter, the tax was further increased and differentiated among landfill and incineration: 475 DKK per ton for landfill and 330 for DKK per ton incineration. This provided a large incentive to push waste treatment away from these solutions. However, after an increase in recycling rates around 2000, the development more or less stagnated (see figure 4.2).

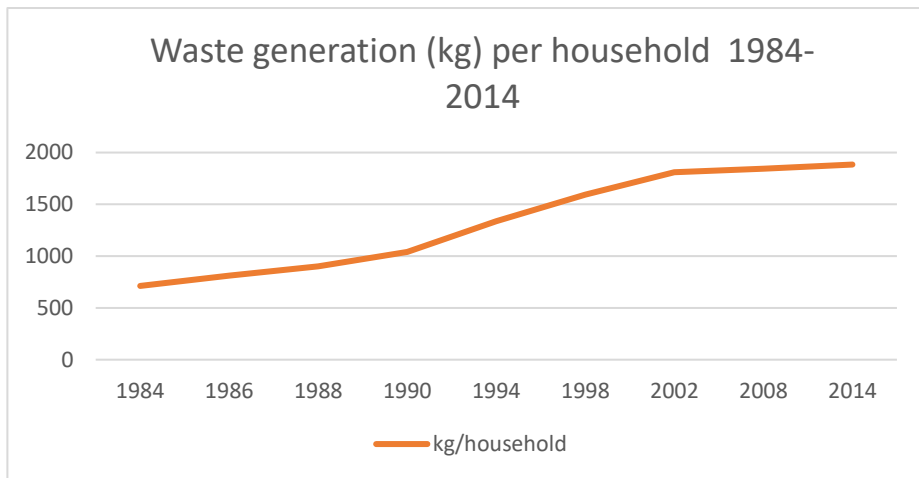


Figure 4.3 From 1984 to 2014 households more than doubled their waste generation.

During the same period (1984-2014), the amounts of waste generated per households more than doubled (see figure 4.3). In combination with population growth, the total amounts of waste collected annually in AVVs area more than tripled (figure 4.4). This meant that even though not much may have seemed to happen in the distribution of waste among treatment solutions, the amounts of waste recycled and incinerated grew substantially.

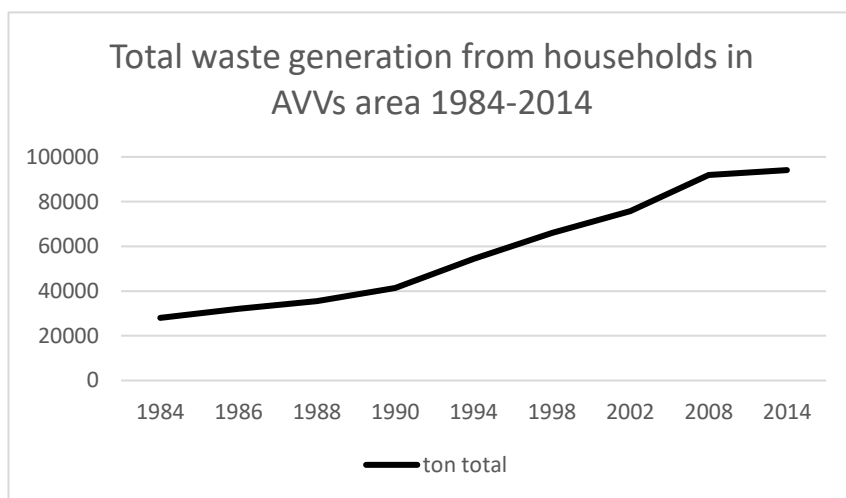


Figure 4.4 The population grew, and so did the amount of waste generated. In total, households in AVVs area generated three times as much waste in 2014 than they did 20 years earlier in 1984.

4.2.2. KEY FIGURES ON HOUSEHOLD WASTE IN AVVS AREA

In total, AVV collected 94,120² tons of waste from the 46,000 households in the owner municipalities. This equals app. 2000 kg annually per household, which is more than the average Danish households generate³. As describes in chapter 1, household waste is collected through bring schemes (bobbles and recycling centers) and through collection at households (the daily discard and curbside collection). The majority of the waste is collected at the recycling centers.

On the left side of figure 4.5 is illustrated how this waste is dispersed in the waste hierarchy in 2016. From 2018, separate collection of waste at the households will be implemented (paper, cardboard, plastics, metal, glass, organic waste). This will change the distribution to become as presented on the right side of the figure.

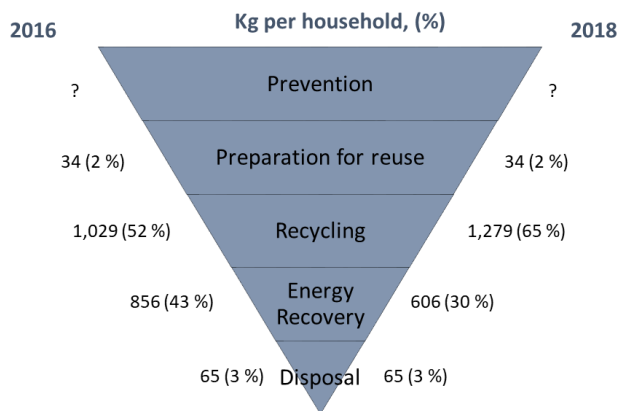


Figure 4.5 Household waste collected in AVVs area is reused (2 %), recycled (52 %), incinerated (43 %), and disposed in landfills (3 %). These figures will change in 2018 with the implementation of increased separation at source (of the daily discard)

² This figure includes some waste from tourists and holiday homes. Additionally, 2-3 % is industrial waste.

³ Accounts of how much waste households generate differ in terms of what is included. This figure includes everything, also garden waste and construction waste from households. These two waste fractions account for a large share of the waste, and are often not included in official accounts, such as the governments resource plan (Miljøstyrelsen, 2014).

Recycling rates are calculated in different ways, and it is not always easy to figure out exactly what is included and what is not. For instance, the EU requirement to ensure a 50 % recycling of household waste only covers the household waste fractions of paper, cardboard, wood, plastic, metals, glass, and organic waste. I have presented the distribution among treatment types of all the household waste. Reasons for this are, that present thesis a) only concerns the waste collected at the recycling centers, b) concern reuse, which is not included in the EU recycling targets.

4.3. THE ROLE OF REUSE IN AVV AND IN THE DANISH WASTE MANAGEMENT

Documents and accounts from AVV prior to 2014 do not distinguish clearly between reuse and recycling, and even though AVV had a reuse shop, the reuse shop did not seem to be perceived as an integrated part of the waste management, cf. the lacking accounts of amounts of products being sold. As one of employees in AVV stated it: *“the reuse shop was just there. We didn’t think much of it. It wasn’t really part of the “real” waste management”*. Nevertheless, AVV was one of the first waste management companies to operate a reuse shop, and throughout the years, visitors from other waste authorities have come to see the shop and learn about how it is managed. AVVs reuse shop is also frequently mentioned in the sector documents and conferences on the topic (for instance on the waste industry associations home page (Dansk affaldsforening, 2017)).

The status of reuse as a part of the official Danish waste management system is disputed. In the executive order on waste (Miljøministeriet, 2012), the waste management option *Prepare for reuse* is placed as the highest priority for municipalities. Yet, in the official recycling targets that were introduced by the government in 2014 (targets to be met in 2020) (Miljøstyrelsen, 2014), waste that is prepared for reuse cannot not be counted as recycled waste. Reuse and preparation for reuse has been a recurring subject for debate in the waste industry during the time I have worked on this PhD project. Most seminally, the Confederation of Danish Industry filed a complaint to the Appeals Board in 2015 (Dansk Industri, 2015). Here they complained that municipalities operate reuse shops and thus compete with privately owned reuse shops in a distortive way. They argued that there are values in waste, and thus a commercial market for it. In June 2017, the Appeals board decided to disregard the complaint, and close the case in favor of municipally operated reuse shops. The Confederation of Danish Industry have encourage a reconsideration of this decision.

4.3.1. THE ROLE OF WASTE PREVENTION IN AVV AND IN THE DANISH WASTE MANAGEMENT

Waste prevention was historically not a part of the municipal waste management. It has never been included in the responsibilities of the municipal waste authorities in Denmark (Miljøministeriet, 2012). However, in AVVs annual information brochure to the citizens, waste prevention has played a recurring role. As in AVVs “Handbook for waste” from 1990, one of the very first pages were devoted to waste prevention. Figure 4.6 shows a copy of the page in the handbook (along with a translation).



Figure 4.6 Even though waste prevention was not an integrated part of the waste management in AVV (and in the Danish waste legislation), AVV encouraged the citizens to prevent waste.

This shows that AVV has always considered the prevention of waste to be important to communicate and encourage the citizens to do.

4.4. CHANGING SOCIETAL NARRATIVES ON WASTE AND RESOURCES

The above history of waste management in AVV takes its outset in a particular discursive framing of the concept of waste. As pointed out by several authors such as Corvellec & Hultman (2012) and Blomsma & Brennan (2017) there has been a change in the societal narrative on waste in recent years. Where waste during most of the 20th century was perceived as an environmental problem to be treated, it is

now increasingly framed as a resource to be managed wisely. For instance, the political strategy for waste from 2015 was not called “*Waste strategy*”, but was called the “*Resource strategy*”. The emphasis in it is, unlike hitherto, on the resources, opportunities and potentials in waste, rather than on the environmental problems associated with waste. The more predominant role of the Waste Hierarchy in recent waste legislation has for one contributed to a more clear distinction between waste prevention, reuse and recycling. Moreover, the concept of the circular economy contributed to the discursive changes by highlighting the business opportunities there might be in the waste resources.

I have chosen to present the historic outline of waste management in AVVs area from an outset in the old discourse (waste as a problem). With this outset, the focus is on how to treat the waste collected. In the following, I will shift my discursive position to the new paradigm of “waste as a resource” which is characteristic to the circular economy concept. When circular economy becomes the conceptual starting point of the analysis, the central points are no longer the waste management as such, but how the values within the waste can most efficiently be utilized. To capture this, the business model concept is useful, because it highlights how value is created, delivered and captured. Companies can have different value propositions, and for this reason, they may have more than one business model. All business model within one company should support the company’s overall strategic objectives (Burkhart et al., 2012). Hence, in the following, I will present AVV in a business model perspective by describing the business models that are present in AVV. This means that instead of describing the different waste treatment solutions, focus is on the outcome of the waste treatment, i.e. the products and services that are the value propositions in AVV.

4.5. AVVS BUSINESS MODELS ANNO 2014

Within AVVs business model, there are multiple value propositions, some being more important than others in terms of both their contribution to the economic viability and to the circularity and sustainability performance of the business. Understanding what constituted the business model in 2014 can become the outset for understanding how innovation within the business model has taken place from 2014 – 2017 and how it can further develop with the aim of increasing AVVs contribution to circularity and sustainability. Hence, in the following section I will describe and analyze the constituent elements of AVVs 2014 business model with an outset in the business model canvas (presented in chapter 2).

4.5.1. BM1: THE SERVICE OF COLLECTING AND MANAGING THE CITIZENS’ WASTE

The main value proposition in AVVs business is the service of collecting and managing the citizens’ waste. In Denmark, waste management is part of the supply

sector. Collecting and managing waste is a service comparable to the provision of other public goods like heat and water, and these provisions all have the common overall aim of increasing the welfare in the society. All citizens have the need to get rid of their waste, and thus the main value proposition in AVV is to meet this need through the service of organization the collection and management of the citizens' waste. More specifically, this service is constituted by the organization of the 18 recycling centers and the subsequent management of the waste (From 2018, the service additionally includes the collection of the daily discard at the households, which has until now been handled by the municipalities⁴).

The customers are all the citizens in the two municipalities and to a minor extent smaller companies who have "household-like" waste (consists 2-3 % of the waste). Whether it is adequate to define the recipients of the waste management service as *customers* can be discussed. There is no doubt that the customer-public company relationship is different from the customer-private company relationship. Firstly, AVV has monopoly on waste management in the area, and AVVs services are provided to ALL the citizens in the two municipalities. Each household pays app. 2500 DKK annually in renovation tax (renovationsafgiften). For this amount, they get their daily discard collected every week, and citizens are provided with the opportunity to bring their bulky and hazardous waste to one of 18 the recycling centers. The citizens are obliged to pay for waste management, and this implies that citizens have no other choice than to let AVV take care of their waste. They cannot chose another, in their eyes better, waste manager. They are thus not customers in a regular sense of the word, where customers actively formulate their needs and chooses from who to buy it (Alford, 2002). The customers of the waste management service may thus more appropriately be termed "*beneficiaries*" (Alford, 2002). In their daily practices, AVV employees use the term "citizens", and for this reason this term will be used throughout the thesis whenever it is this type of customer relationship that is in focus. For citizens, waste management must be convenient (Barr, 2007). If waste sorting becomes too troublesome, not all citizens can be expected to do it. In this regard, the citizen as customer is different from traditional customer-private company relationships. The citizens are not as actively interested in discarding their waste as they are in acquiring the stuff that later will become waste. They may even take the service of waste collection for granted. Nevertheless, public support of the company is important exactly because AVVs waste management is publicly financed. Approximately 50 % of the revenue flows stem from the citizens' fees, and as will become evident in the subsequent analysis of the business model, AVV depend on a good collaborative relationship with their citizen customers.

⁴ There is a division of the waste management tasks between AVV and the municipalities. The municipalities have so far organized the collection of the daily discard themselves. However, from 2018 AVV will take over this task. The reason for this shift is that the task becomes more complex with the implementation of source separation of the household waste.

This value proposition is delivered to the citizens through a close collaboration with the key partners, which for BM1 primarily are the municipality and a transport company. The key activities are the collection of the daily discard at the households (performed by a contracted transporters), and the organization of 18 recycling centers. These are equipped with containers for different waste types, and they are manned by trained staff (see also Article D).

Being the provider of a public service, the logics of the business differs from privately owned companies. The waste sector is heavily regulated and subjected to taxation. Moreover, being a municipally owned company, AVV do not aim to make a profit. The expenses that AVV has on the waste management determine the size of the citizens' fee, and AVV is not allowed to charge more than the cost of the service they provide.

The service of collecting the citizens' waste only constitutes half of AVVs designated tasks. AVV is also responsible of the treatment of the waste. As described in chapter 2, waste treatment solutions are to be prioritized according to the waste hierarchy, and the practical organization of this can also be viewed from a business model perspective. Hence, the following business models within AVV regard the treatment of the collected waste.

4.5.2. BM2: INCINERATION WITH ENERGY RECOVERY

The second value proposition in AVV is the energy recovery from the incineration. Incineration was initially a way to make the waste disappear, when the land for landfills got restricted. When incineration was supplemented with energy recovery it became a more efficient and environmentally better solution. Burning waste for energy replaces some use of fossil fuels; hence, it is an environmentally better solution than landfilling. For this reason, incineration was until recently perceived as a sustainable solution.

AVVs incineration plant is technologically high-end and due to its fluegas condensation it is highly efficient. It produces energy (heat and electricity) for 16,000 households in the area. The recipients are thus some of the same citizens as in BM1 (service). The income from this energy constitute a little less than the other half of AVVs income. 98 % of the income thus stems from a combination of citizen fees and sales of energy. However, the cost of running the incineration plant constitute a major part of AVVs operating costs.

In 2016, 90,000 tons of waste was incinerated. Of this, 23,000 tons was daily discard from households. 8,000 tons was waste collected at the recycling centers. 34,000 tons was industrial waste. The remaining 25,000 tons was imported mainly from other Danish municipalities (Randers, Vejle and Læsø). To reach the capacity of the incineration plant, waste from England and Norway was imported.

4.5.3. BM3: SALES OF THE MATERIALS IN WASTE (RECYCLING)

AVV collects 42 different waste types of which a majority are prepared and sold for recycling. When waste materials are the value proposition, the constituent elements of the business model differs significantly from the two above described business models (BM1: service, and BM2: incineration/energy). Firstly, the customer side of the business model changes. Where the two previous business models operate on a local/municipal market with citizens as fixed customers, recycling of materials take place at a global market under different conditions. Here, the customers are privately owned companies further down the waste management system value chain that process the waste materials into secondary raw materials.

On the supply side, the suppliers of waste materials are the citizens. The better the citizens sort the waste, the higher the quality of the waste materials, and potentially the higher the price.

AVVs key activities related to recycling encompass collection, logistics and transport, preparation for recycling, e.g. sorting, pressing and baling. The character of the marketing of the recyclable materials differ from material to material. Some materials are sold via waste brokers. Others, AVV proactively identify and chose for instance due to one customer's environmentally better management of the waste materials. The customer relationships are also often initiated when AVV is contacted by a customer who wishes to buy waste materials. This was for instance the case with ceramics: a company had developed a new technology for recycling ceramics. They contacted AVV in order for AVV to supply ceramic waste to them. Prior to this, ceramics were deposited at landfills, so this new opportunity to sell ceramics made AVV setup containers for the separate collection of ceramics at the recycling centers.

How the recyclable waste is brought to the market differs among materials. For some material prices differ and vary significantly (for instance plastics). Prices on the market for secondary raw materials do for some materials fluctuate greatly. Unlike what the before mentioned new discourse on *waste as a valuable resource* may indicate, the values in the recyclable waste fractions are insignificant. There are only a few recyclable waste types, that AVV actually makes a profit from selling. These are iron and metals, and cardboard and paper. As all other materials are either given away for free or even paid for to get rid of, the total business of preparing and marketing recyclable waste amounts to a deficit.

4.5.4. BM4: THE REUSE SHOP

Another part of AVVs business model is the reuse shop, in which the value proposition comprises cheap post-consumer products. The reuse shop has existed

since the beginning of the 1980s, and it began as a municipal project for activating unemployed people (as described earlier in this chapter).

Every day, there are 400-500 visiting customers in the shop. The customers are local people who voluntarily visit the shop. Thus, the customers of this value proposition are customers in the traditional sense of the word (actively formulating wishes and choosing from who to buy it (Alford, 2002)).

The products sold in the shop are collected at the 18 recycling centers, where citizens can voluntarily choose to donate reusable things to be sold in the reuse shop rather than discarding them as waste. The types of products sold in AVVs reuse shop include clothes and shoes, furniture, electrical apparatus (mostly kitchen machines), bikes, toys, pots and pans and cutlery, building materials like doors, windows, bricks and tiles, etc. In table 4.2, the relative share of how much each product type accounts for in the total turnover is presented. In total, 1,100 tons of

products, that would otherwise have become waste, are sold in the shop.



Figure 4.7 A citizens delivers some reusable items to at the recycling station. The site attendant (on the left) guides the citizen on where to put it. Below: citizens shop in the reuse shop.



Products sold in AVVs reuse shop and their relative contribution to the turnover	
Kitchen things and small interior	28 %
Clothes and shoes	24 %
Furniture	15 %
Building materials	7 %
Books and magazines	6 %
Electrical equipment and electronics	6 %
Bicycles	3 %
“House & Garden”	3 %
Toys and equipment for children	3 %
Other	5 %

Table 4.2 The relative share of different types of reuse-items sold in the reuse shop

In 2016, the reuse shop had a turnover on six mill. DKK (equivalent to app. 800,000 Euros). This means that the value of the reusable items in DKK per ton far exceed the value of both energy recovered from waste and recyclable waste materials (for more on this see also Article C on value capture). However, preparing the used products for sales is a labor-intensive process. There are twelve employees in the reuse shop. As labor is expensive in Denmark, this part of the business model (the reuse shop) only just balances.

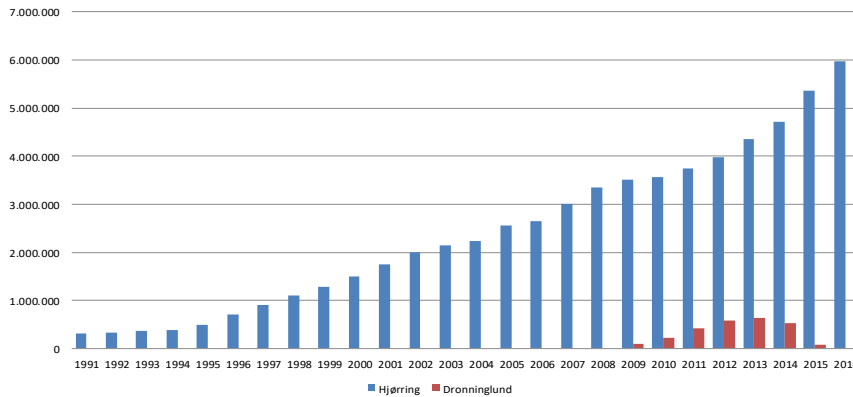


Figure 4.8 The annual turnover in the reuse shop has increased steadily since its beginning. For a short period, AVV operated a shop in a small town, Dronninglund (the red columns). This was shot down in 2015.

Within AVVs area, there are more than 50 other reuse shops. As AVVs reuse shop is municipally operated, there have been questions about distortion of competition. In order to mitigate this, AVVs reuse shop manager have invited all the other reuse shops to a collaboration, in her words “*to make the cake larger, not cut it into smaller and smaller pieces*”. AVV has taken the initiative to make a joint marketing of the local reuse shops, and this has been received well by the other local reuse shops.

For reuse to entail positive environmental effects, the reused items must displace the acquisition of new products. In 2014, AVV made a survey among the customers in the shop. One of the purposes was to investigate the displacement rate⁵. On average, 68 % of the products bought in the reuse shop displace the acquisition of new products.

⁵ This survey did not live up to scientific standards of questionnaire surveys. Hence, the validity and reliability of the results are low. Nevertheless, the survey results can be used as an indication of some tendencies. A future investigation of the substitution rates are recommended

4.5.5. BM5: COMMUNICATION AND KNOWLEDGE DISSEMINATION ACTIVITIES

AVV provides the service of guided tours and waste education to schools and organizations in the area. In 2016, AVV held more than 100 knowledge events. A typical event lasts approximately two hours. The visitors are guided around AVVs facilities and a guide (employee from the innovation department) teaches them about how different types of waste are handled. The visitors are usually also informed about the waste hierarchy, and they are invited to participate in different types of workshops that have some learning objectives. An example of one such workshop is the WEEE workshop aimed at 9-12 year old children. In small groups, the children are provided with an old computer and tools to dismantle it. During the dismantling task, the children learn about the materials used to produce the computer, and how they are handled when they become waste. The children are introduced to life cycle thinking and are invited to reflect upon their own role in the production-consumption system. The practical workshop task and the guided tour provides a



Figure 4.9. Students engaged in a workshop activity dismantling computers

different type of learning than in a classroom setting. Apart from the WEEE workshop, there are also other designs of these teaching events aimed at different target groups (mainly age). The overall aim of these services is to inform citizens about waste handling, and to educate them to prevent waste and sort waste as well as possible.

The school service is free for schools to use, but the other organizations pay a small fee for a guided event. In total, this business model only accounts for an insignificant part of the income. Yet, it requires many resources, particularly skilled employees to perform the guiding events. From a purely cost-efficient point of view, this service adds limited value to AVV and is incommensurate to the resources put into the service. Nevertheless, the teaching activities plays an important role as nursing the citizen relations. As the citizens are also the suppliers of waste materials,

teaching them to sort the waste properly is a way to affect the quality of the supplied materials. Moreover, AVV assesses it to be the best way to encourage waste prevention.

4.5.6. BM6: REMANUFACTURING WORKSHOP, GODT GJORT

The final value proposition encompasses refurbishment of different types of post-consumer products and preparation for reuse of these. This value proposition was first launched in the summer 2016 as a result of a longer experimental process on developing circular activities. I analyze this process more in depth in chapter 7. Organizationally, the repair and refurbishment workshop is associated with the reuse shop, thus under the management of the reuse shop. All the refurbished and remanufactured products are sold under the brand Godt gjort (“Well-done”, author’s translation). The idea is to repair, refurbish and remanufacture post-consumer products in order to delay the time of disposal of waste for recycling, incineration or landfill. In addition to this waste management perspective, the aim is also to create local jobs and help people outside the labor market to develop skills and competences to perform a job and to get integrated to the labor market. For instance, the workshop employs refugees who can build up both their practical skills as well as their language skills.

In the workshop, there are three main categories of waste that is used as input material for the creation of second-hand products. These are bikes, textiles and bricks. On a monthly average, 200 bikes are refurbished and sold in the reuse shop. The bikes are collected at AVV’s recycling centers and in local housing associations.



Figure 4.10 Refurbishment of used bikes

The textile workshop consists of different value propositions. The first one is the manufacturing of cloths for cleaning in workshops, restaurants and similar. The cloths are made of old linen, towels and clothes that are too worn to be sold in the reuse shop for its original purpose. The cloths are sold to local enterprises and consumers in bulks of 20 kg for 250 DKK.

In the textile workshop, clothes and furniture are also made of old textiles. Two Syrian refugee tailors manufacture them, whereas different Danish designers design the products. In some cases, these products are sold in the brand of the designers, in



other cases they are sold in AVVs new brand Godt gjort. These products have so far encompassed jackets, pillows, scarfs, baby bibs and children's clothes.

The Figure 4.11. Sewing of baby bibs from used textiles

final product group consists of old bricks that are polished, washed and sold. This value proposition has required AVV to collaborate with a private company that is called "Old Bricks". They have the technical machinery to refurbish the bricks. AVV manage the collection, thus the supply, and Old Bricks manage the technical operation. Together they have developed a business setup.



Figure 4.12 The counter in AVVs reuse shop is built of old bricks

Within Godt gjort, intern designers and workshop employees continuously experiment to develop new products.

The workshops employ on average 13 people. Yet, there is a frequent replacement of employees, because they are employed as interns in a municipal program for integrating them to the labor market. The aim is that the interns should build up skills while working in AVVs workshop, so that they can get a real job later on.

So far, the activities in Godt gjort are not economically viable. They are an expense to AVV, mainly due to high labor costs associated with the administration and management of the workshop and mentoring of the intern employees. In terms of waste directed from recycling or incineration towards reuse, the amounts make up less than one promille of the collected waste. Thus, the environmental benefits are limited. However, the jobs created provide value not least to the individual workers, but also to the local society and to AVV.

4.6. OVERVIEW OF THE VALUE PROPOSITIONS IN AVV

Within AVV, there are six different value propositions targeting different customer segments and requiring different activities, partners, collaborations etc. Some customers are at the same time suppliers. Figure 4.13 illustrates how the six value propositions co-exist within the same company, and activates different elements of the business model. Moreover, viewing AVVs activities through the lens of the business model concept reveals how the business models are interlinked and depend on each other.

The business models' contribution to the economic performance of AVV differ significantly. The main income is from the citizen fees and the sales of energy. The business models for recycled materials, the reuse shop and the teaching activities only constitute an insignificantly small part of the income. The fact that the main source of revenue is receiving waste, not reselling it, shows that waste is not as valuable resource as it is sometimes portrayed. Even though, reselling waste and its components do not contribute to the economic prosperity they have their legitimacy in their contribution to

- reaching the government set recycling targets
- increasing social equity by providing the ability to less advantaged citizens to buy cheap second-hand products
- educating the public to be a supporting part of the socio-technical system of waste management.
- creating local jobs

In this regard, all the business models contribute to support the overall strategic aim of AVV.

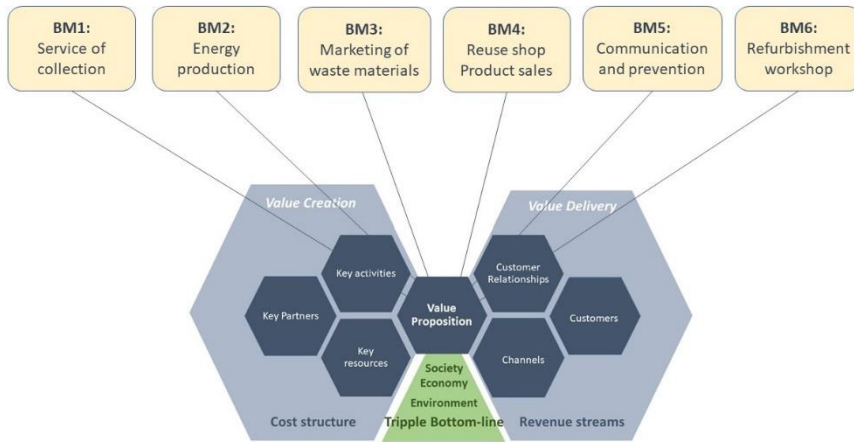


Figure 4.13 Within AVV, there are several value propositions targeting different customer segments and requiring different activities, partners, collaborations etc.

The six business model can also be placed within the circular economy model to illustrate how they contribute to circularity. This is illustrated in figure 4.14. From a circular economy perspective, there are several business models in AVV that holds circular elements, and the fact that only one of these is new shows that waste prevention, reuse and recycling has always played a prominent role in AVV despite the linkages to incineration.

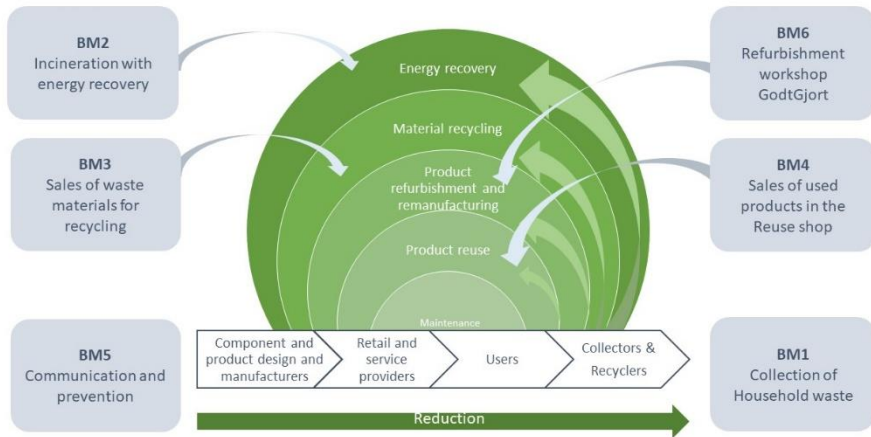


Figure 2.14 From a circular economy perspective, all business models in AVV hold circular elements or are connected to circulation of materials. The second-hand shop have existed for 30 years, but the refurbishment activities are new.

In this thesis, I focus mainly on the inner circles of the circular economy. Thus, the following chapters focus mainly on BM1, BM4, BM5 and BM6. BM6, i.e. the workshop with refurbishment activities was launched in November 2017, thus being very new. Chapter 6 and 7 will reveal more about the process that has taken place to develop these prepare for reuse activities and business model in AVV

4.7. THE CIRCULAR BUSINESS MODEL CONCEPT AS A WAY FORWARD FOR AVV

In this chapter, I have presented the main business models within AVV and how they fit into the circular economy framework. From this outset, the subsequent part of the research project aims to investigate different aspects of the process of developing circular business models within AVV further. It has become clear by the previous analysis of the business activities in AVV that the different value propositions are connected. The service value proposition results in collection of waste, and this collection of waste equals the supply materials from which new value propositions can be developed. Following the waste hierarchy, highest priority should be given to the innovation of new business models for waste prevention and reuse (preparation for reuse), and secondly business models for recycling. For this reason, emphasis will in the remainder of thesis be placed on business models for the upper levels of the waste hierarchy (=the inner circles of the circular economy). Before investigating the more substantive implications of such innovation processes, I will present, analyze and discuss AVVs motivations and visions for embarking upon a circular economy transition. This is because a first prerequisite to engage in

circular business model innovation is that there is a deeply rooted motivation for it among the management in a company.

4.7.1. VISIONS, LEADERSHIP AND MOTIVATIONS IN AVV FOR DEVELOPING CIRCULAR ECONOMY BUSINESS MODELS

Changes within organizations require visions, and the articulation of expectations and visions are considered crucial for niche development “*because they provide direction to learning processes, attract attention, and legitimate (continuing) protection and nurturing*” (Schot & Geels, 2008: 540). Top management anchored visions are moreover seen as prerequisites for changing organizations and businesses, including changes towards sustainability and circular economy (Kraaijenhagen, van Oppen, & Bocken, 2016). Therefore, it is relevant to investigate what has motivated AVV to embark upon a process of developing circular economy inspired projects, including the employment of PhD students to work with this. Even though there has always been an innovative culture in AVV, some of the innovation department’s employees point towards the replacement of the CEO in 2012 as a point from which circular economy and sustainability orientation in AVV became more predominant. For this reason, I asked the CEO for his and the management’s motivations and visions for transitioning to more circular ways of operating. It is probably best described by the CEOs own words:

“Basically, we support this circle to run, because we can see that it is the right thing to do. That is THE solution that we have to the resource challenges...For this reason, I think that we [AVV] try to rise above these business economic issues and rather see ourselves as contributing to solving an environmental and societal problem.

For instance [he names another Danish waste management company], they have decided to disregard all these modern ideas. They say: “We do as we’re used to do, but we will try to do it more cost-efficient”. They think in terms of rational economy. That is one approach. But we have said to each other and in the board that we have a certain equity, we have a certain strength, and we also have a certain obligation. Someone has to take a lead and show a different path. We have to do something else than business as usual. At some point, someone has to do something different, and we have decided that that someone is going to be us [AVV]... That is why we have initiated activities that are at the edge of our core competences. It is because we want to... it is part of the vision of the board and the leader group”

The above citation illustrates the manager’s personal and professional interest in circular economy. He seems to be personally concerned about “*the resource challenge*”. Based on my participatory observation and ethnographic field study interviews, it is my clear impression that he shares this concern with the innovation manager and other employees in the innovation department. The role of the

innovation manager in pushing the agenda further towards sustainability oriented experimentation has been vital. There is thus a motivational driver on a personal level both in the management and among the employees who are to develop new circular projects.

There is also a professional motivation that has to do with “being best”, being frontrunner, an urge to set new standards in the sector, and distancing from conservatism and business-as-usual. The quote indicates a professional pride related to being a frontrunner. Being the best waste management company is explicitly stated as part of AVVs vision, and one of the four company core values is to be a frontrunner. This urge could probably have manifested itself in connection with other conceptual ideas than the circular economy, but in combination with the personal interests in environmental issues, the motivation for embarking upon circular economy becomes stronger than without this professional pride in being visionary.

Similarly important is the fact that the vision is embedded not just in the management and innovation department, but also in the board. The board’s support is a prerequisite for investments in developing new solutions. They experience AVV as well driven (the CEO refers to equity and strength of AVV), and this perception of the company as small but strong supports the new ideas of circular business development.

From a purely business strategic perspective, it can be wise to differentiate one’s business on the market (Sherain, 2014). Developing innovative solutions within the framework of circular economy could be such a strategic differentiation. But AVV has monopoly on waste management in the area, so principally they do not need to compete with others through strategic differentiation. Most waste management companies and municipalities have been pending on political decisions regarding the minister’s announcements about privatization and for this reason, many of them have put their R&D work on hold.

“Who has said that a waste management company should be innovative”?

The question was asked by an employee in the innovation department one day during a discussion. I have asked myself this question too. It is a legitimate question, because nowhere are there any requirements or expectations to a monopolistic public waste management company to innovate. It could be argued that they should simply just comply with the rules and regulations in the most efficient way. Business model innovation is argued to be important for the success of private business, but does this also account to public companies? The innovation manager’s response to this was:

“It doesn’t say anywhere that we should [innovate], but it also doesn’t say anywhere that we shouldn’t. By the waste regulation [affaldsbekendtgørelsen] we are obliged to prioritize according to the waste hierarchy and to do so require that we think innovatively”.

4.7.1.1 Cultural identity in AVV

The culture in the company plays a role too. According to the employees in the innovation department, there has always been a culture of playfulness and creativity. AVV has always had environmental concerns high on the agenda. For instance, AVV had an environmental management program and was certified according to EMAS since 1998. Yet, sustainability did not play the same role in the organizational identity and culture as it does today (reuse shop manager). Under the former director, the slogan seemed to be *“most environment for the money”* (reuse shop manager). Environmentally friendly solutions were chosen, when this did not entail too much economic burden. Today, the environment and sustainability is considered into all decisions and projects, and there may not be one simple reason for this. *“I think sometimes we take a leap forward in our development when different events collide. Around the time, when we got the new CEO, there was also a lot about circular economy in the media... We had Ida Auken with a vision... and didn’t the resource strategy come around that time too?”* (environmental manager).

The reuse shop manager emphasizes a visit AVV had from a consultancy firm in 2011 as turning point for her. This consultant had a motto: *“Everything speaks”*. An example of how things spoke in AVV in 2011 was that all the employees drank their daily coffee in disposable plastic cups, thus creating a lot of plastic waste every day. *“How can we ask the citizens to sort their waste, if we do not even do it ourselves?”* (Reuse shop manager). The replacement of disposable plastic cups with post-consumer cups collected at the recycling center became the first step to *“take our own medicine”* (reuse shop manager). However, as the environmental manager adds: *“We considered it carefully. We investigated the environmental impacts from using the disposable plastic cups with the environmental burdens from washing reusable cups. We didn’t just jump into it”*. The motto of “everything speaks” have later inspired the interior design in AVV: walls are decorated with art made of waste, and the canteen are furnished with post-consumer furniture from the recycling centers. I return to this theme of waste in the interior design in chapter 7.

4.7.1.2 Threats and opportunities

The CEO points towards a particular threat as necessitating and legitimizing circular business model innovation:

“The challenge here is that for some time now there have been forces centrally ... where they say “Those small waste management companies, they are not efficient.

We ought to merge them into four large companies, and then it will become more efficient. Large is lovely.” There we had to understand, that if we are going to survive in the long run when this is the perception held by the central administration, then we have to set another agenda and try to do something differently, try to challenge. We should be the little speedboat in front of the supertanker. If we do not do that, we will resign. We will become smaller and smaller. That might financially be more efficient in the short run, but in the long run our company will die.”

Here the CEO points towards a threat to AVVs future survival in its present form. Being municipally owned, AVV is subject to political control. The prevailing political ideologies affect AVV, and currently, the liberal government prepares to embark a reform to make waste management more efficient. This includes discussions about the possibilities and potentials for privatization of the supply sector (including waste management) based on the idea that a single, competitive market will be more efficient than the current public monopolies. This entails uncertainty for AVV about the future of the waste sector. Thus, the third motivational factor is the perceived threat of a centrally steered efficiency reform or privatization of the waste sector. This threat points towards one of AVVs weaknesses: its smallness. To address this threat and weakness, AVVs management sees a loud transition to more circular and innovative solutions as a strategy for differentiation and influencing the agenda, thereby ensuring their own survival. The management perceives it vital to encounter the threat of privatization by showing that AVV as a publicly driven company can be innovative and first movers in the sector. They see a need to differentiate themselves by, in the manager’s words, “*being the best*”. Innovation processes often start with the goal to create a strategic advantage in the market (Teece, 2010), and this goal of strategically differentiating themselves and the urge to set the agenda can become a catalyzing factor for initiation of an innovation processes.

CHAPTER 5. WASTE PREVENTION

The Waste Hierarchy presents the order of preference of the Circular Economy principles: Waste prevention, including reuse, is preferred to material recycling. However, within many conceptualizations and understandings of the circular economy, prevention or reduction plays a minor role, if any (Kirschherr, Reike, & Hekkert, 2017). Particularly, when the concept is applied by practitioners in businesses the preventive/reduction principle is omitted (ibid). This is understandable, as avoiding production and consumption leaves little room for business value creation.

The circular economy concept is still not a fully established concept (Geissdoerfer et al. 2017; Kirschherr et al. 2017). Since I began this PhD study, my understanding of the concept has developed and so has the way that the concept is dealt with in literature. One of the more recently emerging perspectives of the concept is a growing acceptance of the need for reduction of the material resource flows (and a reduction of waste). This is for instance, emphasized by Bocken & Short (2016). In 2014, this focus on reduction of material flows and the avoidance of waste generation was not prevalent in the circular economy discourse. For this reason, I chose early in the process to **investigate how waste prevention could be conceptualized, understood and applied from the perspective of a municipal waste management company**. This investigation is presented in the following article (Zacho & Mosgaard, 2016).

5.1. ARTICLE A

Title: “Understanding the role of waste prevention in local waste management – a literature review”

Authors: Kristina Overgaard Zacho and Mette Mosgaard

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Abstract

Local waste management has so far been characterised by end-of-pipe solutions, landfilling, incineration, and recycling. End-of-pipe solutions build on a different mind-set than life cycle-based approaches, and for this reason, local waste managers are reluctant to consider strategies for waste prevention. To accelerate the transition of waste and resource management towards a more integrated management, waste prevention needs to play a larger role in the local waste management. In this review article, we collect knowledge from the scientific community on waste prevention of relevance to local waste management. We analyse the trends in the waste prevention literature by organising the literature into four categories. The results indicate an increasing interest in waste prevention, but not much literature specifically concerns the integration of prevention into the local waste management. However, evidence from the literature can inform local waste management on the prevention potential; the environmental and social effects of prevention; how individuals in households can be motivated to reduce waste; and how the effects of prevention measures can be monitored. Nevertheless, knowledge is still lacking on local waste prevention, especially regarding the methods for monitoring and how local waste management systems can be designed to encourage waste reduction in the households. We end the article with recommendations for future research. The literature review can be useful for both practitioners in the waste sector and for academics seeking an overview of previous research on waste prevention.

5.1.1. INTRODUCTION

Waste is one of today's great environmental challenges (European Commission 2015). Much effort is devoted to collect and recover the materials in waste, but from an environmental perspective prevention of waste is preferable to any kind of waste treatment (landfill, energy recovery, and recycling). This is because production and treatment of the products and substances that become waste is avoided. Waste prevention is defined as measures taken before a substance, material or product becomes waste (EU 2008). It comprises strict avoidance of waste, not by recycling, but by reduction of waste generation. The definition also encompasses the extension of the life span of products and reuse; and qualitative aspect of reducing the hazardousness of waste.

Waste prevention can occur in all life cycle phases of a product. For this reason, the legislative framework governing waste prevention covers a long list of different directives and regulations, for instance REACH (EU 2006) and the Eco-design Directive (EU 2009), which aim at preventing waste in the design phases of products. This makes sense, since waste cannot be prevented once it has been generated. So far, waste treatment has been perceived as a completely separate policy field from waste prevention (Wilts 2012). This is because waste treatment is fundamentally comprised by end-of-pipe-solutions, such as collection, landfill, incineration and recycling (Bartl 2014). Hence, prevention has so far had no role to play in the local waste management. In the revision of the European Waste Framework Directive in 2008, one of the changes regarded a stronger focus on waste prevention (EU 2008). Yet even though, waste prevention principally is to be prioritized, it is rarely an integral part of the local waste management (Van Ewijk, Stegemann 2014, Bartl 2014)).

A more specific outcome of the amendment of the Directive was an obligation of the member states to develop national waste prevention strategies. Since waste prevention can occur in all phases of the value chain, it is beneficial to develop overall national strategies. However, the national prevention strategies published so far rarely appoint specific tasks to specific actors (Kjær, Kjørboe 2014), and local waste managers (LWM) are rarely mentioned as a responsible actor. Hence, LWMs are currently not obliged to integrate waste prevention in the local waste management.

Parallel with the national waste prevention strategies, the member states are also required to recycle at least 50 % of the waste from households (EU 2008). This entails changes to the socio-technical system of waste management including development of collections systems, logistics, treatment plants, and marketing and sales of the secondary raw materials etc. In these infrastructural developments LWM play a leading role, because these processes are within the traditional domain of local waste management. Nevertheless, these changes are end-of-pipe solutions. As

is true for other environmental challenges, it is sensible to target the root of the problem rather than only treating the problem once, it has arisen. Hence, reducing the total amounts of waste ought to be the primary objective. Otherwise, society risks investing in waste infrastructure, which would not have been necessary if means for prevention had been taken firstly (Williams, Schneider et al. 2015). For this reason, LMW need to consider what could be done to prevent waste in their geographical area before they bind themselves economically to long term investments in treatment infrastructure. In other words, there is a need for more integrated management of resources (Wilts 2012).

An obstacle to incorporating waste prevention into the local waste management is that prevention and reuse is beyond the traditional obligations of LWM. Therefore, knowledge, understanding and expertise on waste prevention are not common among local waste actors (Sharp, Giorgi et al. 2010b). Within the scientific community, waste prevention has gained increased attention in recent years, and this knowledge could inform LWM on how to embark upon waste prevention locally. Therefore, in this article we present a review of the scientific evidence on waste prevention selected based on what is of relevance to LWMs. LWMs' possibilities to affect waste generation throughout the value chain are limited to the final phases of the products' lifecycle. Local waste prevention initiatives will thus mainly target households and to a minor degree retail and industry in the geographic area of the municipality. This study thus primarily focuses on how to reduce waste in households, and on which instruments LWMs have to affect that.

5.1.2. RESEARCH METHODOLOGY AND FRAMEWORK OF ANALYSIS

The study presented in this article consists of a review of literature on household waste prevention and literature on how to incorporate waste prevention into the local waste management.

The literature review aims at creating an overview of the scientific research on waste prevention made so far and at identifying themes, patterns and conceptual content in the literature (Meredith 1993). In order to ensure systematics, reproducibility and quality of the review, we design our research process with inspiration from Fink (2014): This process is not linear, but iterative with several feed-back loops which refine the literature search and the definition of concepts for the analysis (see figure 5.1)

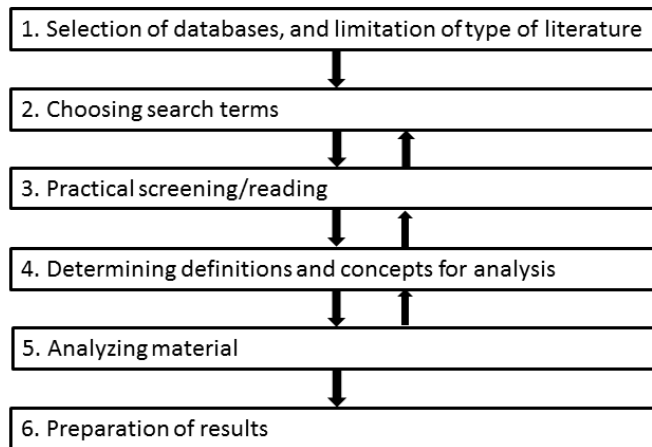


Figure 5.1 The research process of the literature study (inspired by Fink 2014)

The literature reviewed is confined to scientific peer-reviewed papers in English published before November 2015. Reports, books and conference proceedings are excluded. The key words used in the search are “waste prevention”, “household”, and “reuse”, because reuse falls under the definition of prevention (see introduction for definition). These words were combined in different ways and with synonyms (*minimi**, *reduc**, “zero waste”) and scale-specific word was added, that is “domestic”, “local”, and “municipal”. The words were searched for in titles, abstracts and key words in five academic search engines (Scopus, Web of Science, SAGE, Science Direct and Wiley Online Library).

The identified papers were manually assessed in order to remove irrelevant literature for example on sorting and recycling behavior (recycling is not included in the definition of waste prevention). A geographical delimitation was made to ensure that the findings are relevant in a European setting; Only publications concerning prevention of waste in households in developed countries were included in the further review. After this assessment, 50 publications of relevance were identified.

To supplement this search we checked the cited references in the already identified papers as recommended by Webster, Watson (2002) and Fink (2014). This revealed eight additional publications to be included in the review. The low number of papers found by this method indicates validity of the research in the first two steps.

The fourth step in the process includes development of an analytical framework (inspired by Seuring, Müller (2008)). We built the analytical framework upon four main parameters with the purpose to organize, classify and analyze the literature. The four parameters are each divided into analytical sub-categories as presented in

the list below. The parameters and subcategories in the analytical framework were defined during the reading of the literature. It was hence an iterative process going back and forth between reading and developing the framework. This is illustrated in the process model depicted in figure 5.1 with the arrows pointing backwards at previous steps. The four parameters with sub-categories in the analytical framework are presented in table 5.1 below:

Table 5.1: The analytical framework guiding the analysis consist of four main categories each containing a number of subcategories.

Category	Subcategories
Descriptive elements	• Number of publications distributed across time • Journals in which the papers are published
Concept categories	• Potential • Social and behavioral aspects • Monitoring and measuring • Planning and management • Policy
Waste streams in focus	• Broad/not specified • Food waste • Paper waste • Consumer goods • Other
Methodologies applied in the published studies	• Quantitative/surveys • Case studies • Qualitative micro-studies • Modelling • Review • Discussion paper

The first parameter regards descriptive factors encompassing the number of publications distributed across time, and the journals in which the papers are published.

The second parameter regards the substantive focus and content of the literature. This includes themes and concepts for organizing and analyzing the literature, as suggested by Webster, Watson (2002). The overarching aim of this third set of categories was to develop a framework able to extract and organize the knowledge of particular relevance to local waste managers. As this part of the framework

regards the contents of the literature, the analysis of this will play a dominant role later in this article. The choices of categories deserve some elaboration:

The first subcategory is named “*Potential*”. This category includes papers which regard the reduction potential of different waste streams; the environmental impacts of prevention; the social and economic potentials in waste prevention and reuse. Knowledge on the potential for preventing different waste streams is important for local waste managers’ planning process. So is knowledge of the environmental significance of preventing different waste streams. Intuitively, the avoidance of waste must reduce the environmental impacts, but information about the magnitude of the reduction potential and the significance of avoided environmental impacts is central for the planning in LWM and for setting realistic objectives. Lack of this information may in itself be an obstacle for considering waste prevention.

The second subcategory we call “*Social and behavioral aspects*”. Understanding what constitutes and changes waste prevention behavior and practices is key to developing successful intervention campaigns or systems to encourage and enable prevention and reuse.

The third subcategory, “*monitoring and measuring*” regards how to monitor and measure waste prevention, for instance through the use of indicators. Knowledge of this is important for LWMs when they design waste prevention programmes and initiatives, because monitoring is crucial for reliable evaluation and assessment of effects and results.

The fourth subcategory is particularly central to this article. It regards “*Planning, Management and policy*” of waste prevention in the local waste management, which is the overall theme of this study. In this subcategory knowledge we collect literature which discusses how waste prevention can be applied in the local waste management. The category does, however, also encompass policy issues at larger scale, but this will play a minor role in the final analysis of this article.

We also organize the literature according to which waste stream is in focus. The waste stream categories are chosen based on what we found in the literature. Since not all waste streams has been investigated from a prevention point of view, our waste type categories only encompass food waste, paper waste, consumer goods.

The last parameter regards the methodologies applied in the publications. This category is divided into six groups, covering different quantitative and qualitative types of methods (point 2 in the list above). The purpose of this is to establish an overview of how, and with which methods, waste prevention as previously been investigated.

In the review, we thus map publications according to their focus, and each article we assign to one category within each of the parameters. To exemplify this, Barr (2007) is categorized as using quantitative methods (questionnaire); regarding social and behavioral aspects of waste prevention; and concerning waste broadly (no one specific waste type). This is depicted in table 5.2.

Barr (2007):		
Methodological Approach	Concept category	Waste stream
Quantitative (questionnaire surveys, data analysis)	Potentials in Waste prevention (including potentials for reduction, environmental benefits, social aspects)	Food waste
Qualitative micro studies (interviews, observation)	Social and behavioral aspects	Paper waste
Case studies (mixed methods)	Monitoring and measuring	Consumer goods
Review	Planning, management, policy	Broad/not specified
Modelling		
Discussion paper		

Table 5.2 Example: Categorization of Barr (2007)

In the reference list, this is visualized as Barr (2007) [Quant, social, broad] in order to ensure transparency.

In the cases where articles cover more themes, we categorize them according to the most dominant theme of the article.

The contents of present article is structured according to the analytical framework. Firstly, we present the descriptive analysis, secondly the conceptual analysis (based on the categories 3 and 4), and finally we discuss the findings and their implications

for local waste managers. We moreover point out directions for future research in the last part of the article.

5.1.3. ANALYSIS/RESULTS

5.1.3.1 Descriptive analysis

In the following, we analyze the basic statistics of when the publications were published, their methodological approach and the concepts and waste types they concern. Thereby we show trends in the academic interest in the subject.

5.1.3.2 Publication year

The relatively low number of publications (58) shows that waste prevention has not been devoted much attention in research. However, during the last seven years there has been a steady increase in publications indicating a growing interest in the topic. Figure 5.2 illustrates how the publications are dispersed over time in the period 1996-2015.

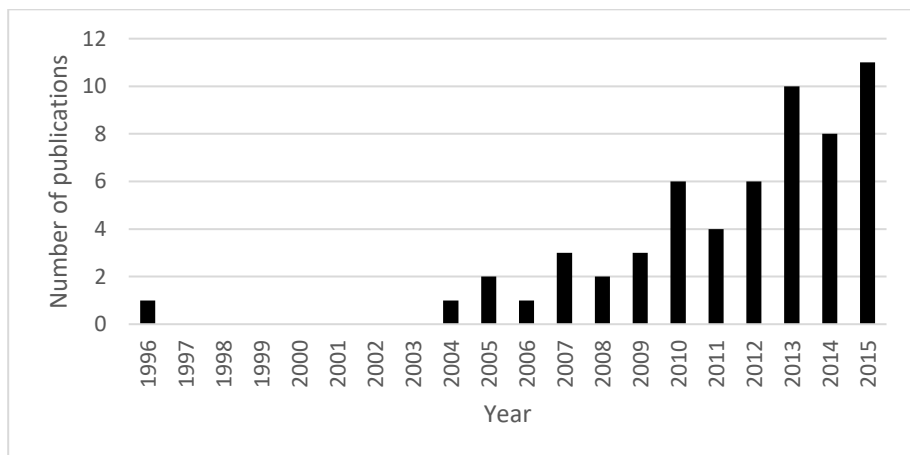


Figure 5.2: Since 2009, there has been an increase in the number of publications regarding waste prevention

The increasing amount of studies on waste prevention can be linked to changes in waste related policies in Europe. In 2008, EU made an amendment to the Waste Framework Directive, requesting all member states to formulate national WP programs (EU 2008). This created a need for knowledge and research in the field, which may be reflected in the increasing number of publications in the recent years. A closer look at the peak in 2010 reveals that all the publications from this year are based on British studies. Already in 2003, the British Defra established its Waste and Resources Evidence Program, and waste prevention was emphasized as a

priority (Cox, Giorgi et al. 2010). Hence, research on prevention was also prioritized and several studies was initiated and led by Defra's Waste and Resources Evidence and Action Programs (WREP and WRAP). There are reasons to believe that waste prevention will be subject to more research in the coming years due to the obligation of EU member states to develop prevention program.

5.1.3.3 Journals in which the papers are published

More than half of the articles (38) are published in three journals: 19 in *Resources, Conservation and Recycling*, 11 in *Waste management and Research*, and 8 in *Waste management*. This indicates that the subject of waste prevention is embedded in the waste management literature more than in greater sustainability literature. This is interesting in the light of the discrepancies between traditional end-of-pipe waste management and the life cycle based approach to waste and resource management. Being a transdisciplinary research field however, literature on waste prevention could have interest to other groups too, such as environmental planners and managers, or others working within sustainability issues more broadly.

5.1.3.4 Definitions of waste prevention in the literature

"Minimization" is often used synonymously with "prevention". However, papers using the term "minimization" and "zero waste" generally work with a wider understanding of prevention including reduction of the residual waste through sorting for recycling and/or incineration. This only prevents waste from going to landfills. Examples in literature are Farrelly and Tucker (2014) and Cole, Osmani et al. (2014). Also the much promoted San Francisco Zero Waste case operates with waste minimization, not prevention as it is defined by EU and OECD. Other studies include both prevention and recycling and thus ends with a mix more similar to the minimization studies. Ferrara, Missios (2012) is an example of this. Among researchers, there seem to be consensus that motivators and barriers for prevention are not the same as for recycling (Barr 2007, Tonglet, Phillips et al. 2004). For this reason, a clear distinction and a consciousness of the differences between the two terms, *prevention* and *minimization*, is important especially for waste managers who work with both recycling, reuse and prevention.

5.1.3.5 Concept categories

The papers are divided into categories in order to investigate which aspects of waste prevention they deal with.

The concept categories are

- (1) Potential/impact,
- (2) Social/behavior,
- (3) Monitoring and measuring effects,
- (4) Planning, management and policy

Figure 5.3 shows the distribution of the papers upon the conceptual categories (we stress that not all papers fit equally well into these categories, and some papers have thus been categorized according to the aspects that receive most attention in the given papers). This reveals that within the theme of household waste prevention, most studies (22) concern behavioral aspects of the individual or the household. The second largest group of papers regard planning and policy aspects of waste prevention, and these constitute 21 articles. This category also covers management aspects of reuse. Moreover, this category contains papers concerning waste prevention policy at different scales. Hence, not all of these are equally relevant for the practical implementation of prevention in LWMs. 10 papers assess the waste prevention potential of different waste streams and/or the environmental impacts of reducing these streams. The category receiving the least attention is *Monitoring*, as only 5 papers regard this.

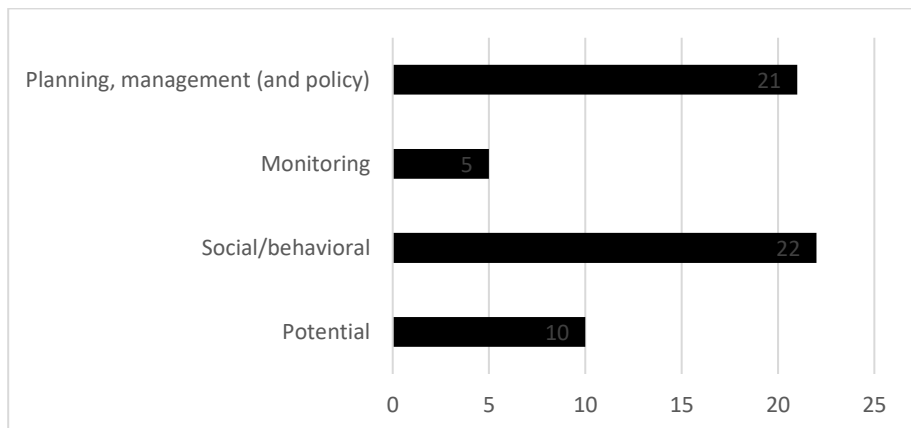


Figure 5.3: The scientific papers are distributed between the four concept categories

The conceptual categories will be unfolded in section 5.1.4.

5.1.3.6 Waste streams

By categorizing the publications according to which waste streams they address, we show which types of waste has been in focus in previous research. Some authors (Fell, Cox et al. 2010, Zorpas, Lasaridi 2013) argue that to be successful, prevention initiatives should address specific waste streams. The reason for this is, that prevention, for instance of food, paper waste or through reuse, consists of different actions, are motivated differently, and thus requires different approaches for engaging and for monitoring. Moreover, some waste streams hold larger prevention potential than others, and this is important for effective planning of prevention initiatives. Hence, it is relevant to investigate state-of-the-art scientific literature within household waste prevention of specific waste streams.

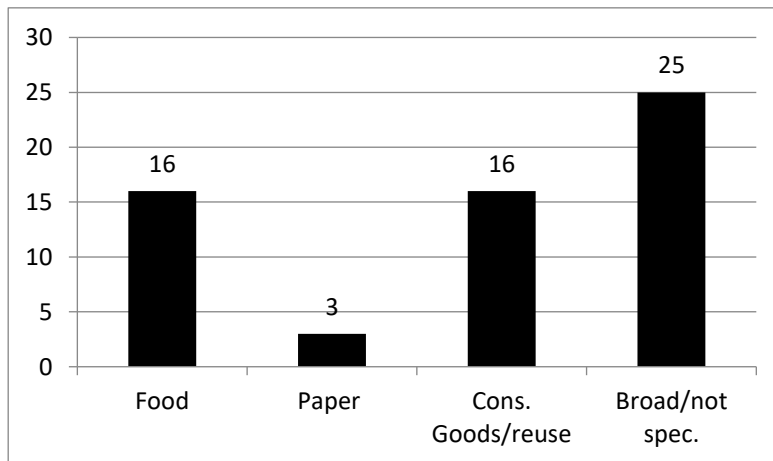


Figure 5.4: Different waste streams are in focus in some articles, but most of them regard reuse or prevention more broadly

Most studies (25) concern municipal or household waste broadly without specifying the waste type. 16 papers regard food waste, and 16 regard reuse of consumer goods. Of these, a large part concern reuse of furniture and electrical appliances and this is often investigated from a managerial perspective, for instance by Fortuna and Diyamandoglu (2015), Kissling, Ramon et al. (2012) and (2013), and Ongondo et al. (2013).

A few publications concern specific waste types such as paper waste (Gentil, Gallo et al. 2011), (Puig-Ventosa, Jofra-Sora et al. 2014) and (Salhofer, Obersteiner et al. 2008), who also includes diapers. Salhofer, Obersteiner et al. (2008) and Gentil, Gallo et al. (2011) also investigates prevention potentials for beverage packaging,

but this prevention is through diversion to recycling. Hence prevention of packaging is not included further in this review.

5.1.3.7 Methodologies applied in the studies in the papers

The studies in the published papers have applied six different types of methodologies according to the focus of the studies. Waste prevention is a phenomenon consisting of different elements such as waste statistics, social behavior of the individuals, organizational aspect, different interests etc. Being a transdisciplinary field, there is a need for different types of research approaches as they can complement each other by revealing different kinds of results. To understand waste prevention in its entirety would call for a mixed method approach, such as case studies. There are 10 case studies in the previous literature. However, the single constituent parts of waste prevention can be investigated through different approaches. The methods previously used to investigate different aspects of waste prevention determines what we know about the subject. Hence, it is relevant to elucidate which type of methods that were previously applied in the studies in the different concept categories.

The largest and most extensive review study has been conducted by British researchers. Their work is presented in the three of the four review articles, and they build on a mixed methods approach. These are (Cox, Giorgi et al. 2010), (Sharp, Giorgi et al. 2010b) and (Sharp, Giorgi et al. 2010a). They review evidence on household waste prevention in UK through a variety of sources, such as local prevention initiatives, studies conducted by WRAP and other. Also the discussion paper by (Fell, Cox et al. 2010) build on this study.

Seven papers are categorized as modelling papers, covering mainly life cycle assessments and IO (input-output) models, obviously building on quantitative data. Eleven papers discuss different aspects of prevention. These discussion papers cover a wide range of aspects of waste prevention, such as de-coupling of waste from economic growth; discussions of life cycle assessment methods for assessing environmental impacts of prevention; the role of prevention in municipal waste management and other.

As presented in figure 5.3, 22 of the 58 studies regard the social and behavioral aspects of waste prevention. In the investigation of social phenomena, both quantitative and qualitative research methods are eligible. They can even be complementary (FIRESTONE 1987). Looking at the statistics of which methods are applied in the literature on the social aspects of waste prevention, reveal that more than half the studies (14) apply quantitative research methods, that is questionnaire surveys. Primary qualitative research only account for six of the papers. In quantitative research, it is assumed that there are social facts and an objective reality to be uncovered, whereas the qualitative research holds that reality is constructed

(FIRESTONE 1987). The quantitative studies on waste prevention behavior often build on theory of planned behavior and use quantitative data to investigate this, hence seeking to validate or falsify preconceived perceptions. Due to the complexity of the subject, deductive research generally fails to explain waste prevention behavior in its entirety. Moreover, there is a tendency to build research on questionnaires with self-reported behavior. This method should be used cautiously, because as Thøgersen (2003) points out individuals are inclined to present themselves more “good” or “green” than they actually are. Graham-Rowe, Jessop and Sparks (2014) and Bulkeley, Gregson (2009) argue that understanding the practices of the individual is a prerequisite for developing successful instruments and measures for prevention. As qualitative research aims more at *understanding* the social phenomenon (such as waste prevention) from the actors’ perspectives (Taylor, Bogdan 1984), there may be a need for more studies of this type.

5.1.4. CONCEPTUAL ANALYSIS

5.1.4.1 The potentials of waste prevention

The basic information upon which a municipal waste management system is planned and operated is the amounts and composition of household waste generated (Beigl, Lebersorger et al. 2008). This is also the basic information needed firstly to assess the potential and relevance of waste reductions, and secondly to prioritize focus areas, i.e. waste streams, for prevention strategies.

Firstly, it is important to stress that reduction of all household waste is not possible (Bartl 2014, Gentil, Gallo et al. 2011). For household waste broadly speaking, 0.5 - 1 kg waste per household per week can realistically be achieved for instance through campaigns (Cox, Giorgi et al. 2010). There is moreover agreement in literature that the highest prevention potential is found in food waste and secondly in paper waste. The main reason for this is that individuals in households can more easily affect the generation of these types of waste than other types, such as plastic packaging. The actual potentials depend on the waste composition in a community. Salhofer, Obersteiner et al. (2008) suggest a 20 % reduction of both food and paper waste to be realistic in Austria, whereas Bernstad, Schott et al. (2013) suggest that 35 % of the food waste in Swedish households is avoidable. Sharp et al (2010a) found that 1.5 kg of food waste could be avoided in British households.

Gentil, Gallo et al. (2011) assess the environmental impact potential from Salhofer, Obersteiner’s 20 % and concludes that preventing food and paper waste has high environmental impacts due to the upstream effects of avoided production. Bernstad, Schott et al. (2013) concludes that prevention of food waste has higher environmental impacts than any treatment option like incineration and anaerobic

digestion would have. Hence, waste prevention of these two waste streams could play a significant role in resource conservation and climate change mitigation.

According to the definition, reuse is included in waste prevention. Based on case studies, Curran and Williams (2010) estimates that reuse of bulky waste, such as furniture could be increased significantly in the UK from 2-3 % to 40 %. Cox et al. (2010), Bulkeley, Gregson (2009) and Kissling, Fitzpatrick et al.(2012) also consider reuse as a way to prevent waste, but they do not assess the prevention potential quantitatively. In general, reuse only reaps environmental dividends if the reused products replace the acquisition of new products, but no studies were found which accounts for replacement rates of different product groups. Moreover, reuse may actually fuel consumption, as the money saved by buying second-hand goods can be used for acquiring new products, as suggested by Bulkeley, Gregson (2009). Truttmann and Rechberger (2006) assess the resource conservation potential from reuse of electrical appliances to be up to 33 %, but to be however insignificant compared to efficient recycling, which achieves higher contribution to resources conservation. Hence, they recommend that other considerations than those of resource conservation should contribute to the decision of whether to invest in reuse or not. The environmental impacts of reuse are thus largely undiscovered, and future attempts to assess them require a judicious definition of system boundaries.

There may also be a considerable social potential in including waste prevention and reuse in the local waste management. Social perspectives as emphasized by Curran and Williams (2010) and Cox et al. (2010) include the fact that reuse and second-hand goods give people from low-income households the ability to maintain good living standards at affordable prices. Moreover, this reuse must be expected to replace consumption of new items, consequently, entailing environmental benefits. Local job creation and reintegration of marginalized people outside the labor market is also emphasized by Curran and Williams (2010) and Gelbmann and Hammerl (2015). Christis, Geerken et al. (2015) moreover suggest that there is an economic potential in reuse as well. Reuse may thus have potential to contribute to all three dimensions of sustainability.

5.1.4.2 Social- and behavioral aspects of waste prevention

Individuals generate household waste through their daily practices. Hence, an obvious strategy to reduce waste would be to make individuals change behavior, for instance through campaigns, initiatives and/or by organizing the waste management system and services in a way that promotes waste prevention. Development of such initiatives and systems requires understanding of what constitutes and changes waste generation and prevention behavior (Abeliotis, Lasaridi et al. 2014), (Bortoleto, Kurisu et al. 2012), (Bulkeley, Gregson 2009).

The apparent need for understanding waste prevention in households may be the reason that a majority (22) of the literature concerns behavioral and social aspects. Nine of these concern prevention behavior broadly across waste streams, another nine specifically concern food waste, and four specifically concern behaviors and practices related to reuse.

There is consensus in literature that prevention behavior is different than recycling behavior, hence requiring different approaches to engage individuals (Bortoleto, Kurisu et al. 2012, Cox, Giorgi et al. 2010, Barr, Guilbert et al. 2013, Tonglet, Phillips et al. 2004, Ferrara, Missios 2012, Barr 2007). Sorting for recycling occurs once products and substances have become waste, whereas waste prevention occurs in a variety of situation unrelated to waste, such as shopping and cooking. This makes prevention behavior a complex issue consisting of a complex mix of actions (Barr, Guilbert et al. 2013, Cox, Giorgi et al. 2010, Quested, Marsh et al. 2013), related to a variety of different physical contexts (Bulkeley, Gregson 2009) and susceptible to a diversity of factors (Parizeau, von Massow et al. 2015).

Table 5.3 presents examples of waste preventing actions undertaken by individuals in their daily practices.

Table 5.3 Practical waste prevention behaviors performed by individuals/households (based on (Brook Lyndhurst, RRF (Resource Recovery Forum) 2009) with additions from Graham-Rowe, Jessop et al. (2014), Zorpas, Lasaridi (2013)

Behaviour domain	Examples of behavior in practice
Junk mail	Signing up to Mail Preference Service
Reuse	Donation, buying second-hand or selling Everyday practices e.g. reusable bags Buying and using refillables Using self-dispensing systems
Sharing	Product service systems Leasing Sharing products with others, e.g. garden tools
Smart shopping/purchasing choices	Avoid single-life products Avoid offers (e.g. buy one get one for free) Avoid bottled water Reject over-packaged goods Buying loose products/in bulk Buying only the amount of products needed
Food waste prevention	Planning meals Planning shopping for meals Reuse leftovers Correct storage of food
Home composting	
Repair	Try to repair broken goods rather than renewing them
Other	Reduce household hazardous waste (e.g. use eco-labelled cleaning products)

Waste prevention behaviors are influenced by concerns for the environment (Bortoleto, Kurisu et al. 2012, Ferrara, Missios 2012, Barr 2007); moral obligation (Bortoleto, Kurisu et al. 2012, Graham-Rowe, Jessop et al. 2014), altruistic attitudes (Cecere, Mancinelli et al. 2014), avoidance of negative emotions, such as guilt; and inconvenience (Bortoleto, Kurisu et al. 2012). Unlike recycling behavior, prevention

behavior is not motivated by social pressure (Cecere, Mancinelli et al. 2014, Bortoleto, Kurisu et al. 2012) nor does it seem to be motivated by economic incentives (Cecere, Mancinelli et al. 2014). Hence, prevention campaigns should stimulate general environmental attitudes among consumers in order to enhance environmental values (Bortoleto, Kurisu et al. 2012)

Adding to the complexity, individuals are often put in dilemmas between prevention and other aspirations. Prevention actions can for instance be in conflict with aspirations to serve good and plentiful food (Graham-Rowe, Jessop et al. 2014) or shop more than you need (Barr, Guilbert et al. 2013). The prevailing social norms encourage mass consumption, not second-hand goods or frugality (Cox, Giorgi et al. 2010). Consumerism is mentioned as a barrier for prevention by Fell, Cox et al. (2010), Barr, Guilbert et al. (2013), Graham-Rowe, Jessop et al. (2014) and Cox, Giorgi et al. (2010). Contrary to this, avoiding food waste does not require a reduction of consumption (Salhofer et al. 2008) and thus does not conflict with consumerism. Other barriers for waste prevention are habits; and lack of tools, skills and knowledge (Cox, Giorgi et al. 2010, Barr, Guilbert et al. 2013). Hence, education and clear instructions on how to prevent waste in practice is suggested as a tool to encourage WP behavior (Bortoleto, Kurisu et al. 2012, Williams, Wikström et al. 2012).

Due to the complexity of prevention behavior, there is also agreement in literature that changing behavior towards more prevention is not merely a question of changing attitudes. Abeliotis, Lasaridi et al. (2014) show that people are generally positive towards prevention of food waste and they perceive food waste as an issue of concern. Did they act in accordance with their attitudes; there would be no food waste. This illustrates that prevention of food waste is not just a question of lacking knowledge and attitudes. Parizeau, Massow (2015) rather highlights the need for education and skill-building. Information as a tool to affect behavior only has effects if the recipient of the information are “tuned in” on the subject. As people generally are concerned with food waste, information is one of the suitable tools to affect food waste (Huhtinen 2009).

Evans (2011, 2012) argue that prevention of household food waste is not just an issue of making the individual change behavior, but that interventions should target more broadly the ways in which food is provisioned, such as infrastructures of provision and the significance of packaging (Williams, Wikström et al. 2012). Similarly, Cox et al. (2010) discusses how organizations and policies can *enable* prevention and reuse rather than leaving the responsibility to the individual. Barr, Guilbert et al. (2013) also warns against relying too much on the role of the individual in reaching waste prevention targets.

There is thus a tendency in literature to move away from an emphasis on actor-centered solutions towards solutions, which seeks to bridge the actor-structure dualism.

5.1.4.3 Reuse and consumer goods

Reuse is by definition a part of waste prevention. Cox et al. (2013) investigated the related topic of consumer attitude towards the lifetime of products, and found that consumers have come to expect frequent updates of products. Acquisition of new products moreover plays an important role for personal identity. In addition to this, the environmental consequences of the “throwaway society” do not seem to burden consumers with concerns (Cox, Griffith et al. 2013). Hence, products are replaced more frequently and cause a surplus of goods. Bulkeley, Gregson (2009) and Gregson, Crang et al. (2013) also emphasize the distinction between surplus of goods and waste. They state that second-hand goods are not in the category of waste, but are unwanted surplus goods that are too good to be discarded. Hence, reuse occurs in most households and is a rather common practice (Bulkeley, Gregson 2009, Cox, Giorgi et al. 2010, Gregson, Metcalfe et al. 2007). For instance, when the parents’ TV is updated to a newer model, the teenage son inherits the old TV and it is moved to his room. Reuse is thus almost taken for granted, and Bulkeley, Gregson (2009) argues that when reuse does not occur and things are thrown away as waste, this is a symptom of absence of social connections in which the reuse can occur. This absence of recipients for unwanted surplus goods is documented to exist in New York, where Fortuna, Diyamandoglu (2015) found that supply of used products exceeded the demand.

According to Gregson et al. (2013), it is not environmental concerns that drive reuse, but rather social concerns and thrift. Donating and circulating surplus things is perceived as the right social thing to do, but more importantly buyers and sellers of second-hand goods do it to make a good bargain (Gregson, Crang et al. 2013). Hence, reuse is not an expression of decreased consumption, but rather the opposite: Reuse enables increased consumption, and “*For buyers, second-hand goods are a means to saving money but also of making that money go further to allow for more consumption*” (Gregson, Crang et al. 2013). The environmental benefits from reuse thus depend on whether the reused items actually replace new ones. Different product categories are more prone to replace new products, but the literature does not unfold this in detail. Baby items, such as clothes, high chairs, cribs and prams are mentioned by Gregson, Crang et al. (2013) as a product category, which do replace new products.

5.1.4.4 Monitoring and measuring household waste prevention

Monitoring is one of the main tools to build strategic plans for effective waste prevention initiatives (Zorpas and Lasaridi (2013)). The ability to monitor and

measure the effect of waste prevention initiatives is necessary to evaluate the initiatives. Moreover, management of waste prevention projects and initiatives relies on setting targets. Tracking progress against targets depend on good monitoring methods (Sharp, Giorgi et al. 2010a). In 2010, Sharp et al concluded that very little is understood about monitoring methods and measures for waste prevention. Since then, only three studies specifically on monitoring waste prevention have been published in scientific articles. This means that to date, there is no general method to monitor and evaluate the effects of waste preventing measures. This may be the greater challenges for waste prevention to be prioritized.

It is not surprising that so little is known about the subject, given the limited research on monitoring. The review analysis shows that five papers concern monitoring. Only one of these papers focus on a specific waste stream, which is reduction of paper waste through stickers for unsolicited mail (Puig-Ventosa, Jofra-Sora et al. 2014). The remaining four regard household waste more broadly. These are Read (2009), Sharp (2010b), Wilts (2012) and Zorpas and Lasaridi (2013). Only the papers by Read (2009) and by Puig-Ventosa, Jofra-Sora et al. (2014) present original research, whereas Sharp, Giorgi et al. (2010b) and Zorpas and Lasaridi (2013) review and discuss other prevention initiatives. The authors of these two papers have thus not designed practical studies with the aim at investigating monitoring methods at first hand.

One of the reasons that waste prevention is so difficult to monitor is, that it can only be measured indirectly as the amount of waste that would have been generated if no prevention measures had been taken (Sharp, Giorgi et al. 2010b). Off course, reductions from one point in time to another can be detected through weight-based monitoring, but it is difficult to attribute the changes to specific measures or random structures such as cultural changes or increasing environmental awareness (Wilts 2012). For instance, reductions in waste tonnages since the 1980's are more likely caused by the use of lighter packaging types and increased recycling than by waste prevention practices in the households (Petersen, Kaysen et al. 2012). In previous case studies, it has not been possible to determine exactly which measures influenced the documented waste reductions (Sharp, Giorgi et al. 2010b, Read, Gregory et al. 2009). Lasaridi et al. (2015) have developed a tool to assist local Authorities in monitoring waste prevention, which build on tonnages. The tool has however not yet been tested.

Output indicators such as tonnage of waste, are not the only type of indicator. Wilts (2012) discusses indicators for national waste prevention and advocates for the need for more process-oriented indicators. This could for instance include the number of prevention campaigns during a year or the number of people reached by a prevention campaign.

Sharp et al. (2010b) has collected evidence from a number of different British studies and identified the tested methods for monitoring. None of the other articles adds significantly to this, hence Sharp et al.s list is presented in table 5.4: supplemented with additions from Zorpas and Lasaridi (2013), Wilts (2012) and Kjær and Kiørboe (2014).

Table 5.4: List of different methods and indicators to monitor waste prevention

Methods for monitoring the effects of waste prevention measures	Suggested by
Self-weighing, monitoring or reporting	Sharp et al. (2010b)
Use of collection round data to accurately measure waste arisings	
Use of control or pilot groups/areas	
Attitude and behavior surveys, including questionnaires, interviews and focus groups	
Participation monitoring, e.g. number of registrations to Mail preference service	
Compositional analysis	
Conversion factors, estimates and modelling	
Hybrid – a combination of one or more of the above	
POS (point of sale)	Zorpas and Lasaridi (2013)
Indicators: investments in WP Number of prevention campaigns annually Number of people reached by campaign Number of people employed within waste prevention by local authorities Number of reuse shops Turnover in reuse shops	Wilts (2012) (Kjær, Kiørboe 2014)

There are also challenges in relation to monitoring reuse of consumer goods and appliances. It is for instance difficult to convert from tonnage to numbers and vice versa (Ongondo, Williams et al. 2013). In relation to reuse other indicators could be the number of second-hand shops, or the turnover of second-hand shops (Kjær, Kiørboe 2014).

To sum up, the need for research on monitoring methods still exists. This regards both weight-based measures and other types of indicators. Especially, there is a lack of first-hand research where prevention studies are designed to collect and assess primary data.

5.1.4.5 Planning and management

Planning, management and policy related studies account for 21 papers, but many of the other articles also reflect on the policy and planning implications of their findings. Much literature investigates barriers and drivers for waste prevention including for reuse, and some of provide suggestions to LWM as to how they can incorporate prevention in their waste management.

A barrier frequently mentioned is the lack of financial support for prevention (Zorpas, Lasaridi et al. 2015). From a societal point of view, a reduction of the amounts of waste, for instance a 35 % reduction of food waste, would entail an economic advantage, but the individual LWM Company has expenditures related to collection and treatment of waste regardless of the amounts. The effect of a reduction of the most realistic waste streams, that is food and paper waste, may even make the collection and treatment cost per unit higher. This is not in the economic interest of LWM, who favours cost-effectiveness (Bartl 2014, Van Ewijk, Stegemann 2014). However, from a long-term perspective it is not in the interest of LWM either to invest in infrastructure to treat waste which could have been avoided (Williams, Schneider et al. 2015).

The lack of willingness to prioritize prevention economically is also caused by current regulation. LWM are not obliged, nor encouraged to prevent waste in the current legislative framework. LWM's prime responsibility is to *manage* the waste that is already there. Preventing waste from becoming is a completely different rationale from management (Corvellec, Zapata Campos et al. 2013, Wilts 2012).

Other barriers are lack of organizational capacities and knowledge. Prioritizing prevention requires leadership (Zorpas, Lasaridi et al. 2015)

Thyberg and Tonjes (2015) have presented a waste management framework in which prevention can be incorporated. It builds on the plan-implement-evaluate-

improve principle. This framework provides a tool to ensure a comprehensive planning process. Among other, it encourages to make considerations regarding data collection and monitoring methods. Similarly, Lasaridi, Hazi et al. (2015) have developed an online tool for monitoring prevention initiatives. An important point of the planning process is the setting of specific targets. Setting targets for the reduction of residual waste over time will encourage LWM to include prevention in plans (Cox, Giorgi et al. 2010) entailing that prevention becomes more than merely an expression of ambitions (Corvellec, Zapata Campos et al. 2013).

5.1.4.6 Prevention initiatives

Different practical prevention (avoidance) initiatives that could be embarked upon by LWMs can be derived from the literature. These mainly cover economic, infrastructural, and information based incentives. For instance, Bulkeley, Gregson (2009) warn against economic charging systems that penalize discarding of waste. The result of charging may be that people dump their waste at unpredictable sites.

Food waste seems to be an easier target for prevention initiatives than other waste streams. The argument is that messages regarding the environmental and economic benefits and the social justice element of reducing food waste are more easily communicated to the public. Campaigns on food waste prevention should include measures that can improve consumers' food management skills (Graham-Rowe, Jessop et al. 2014), for instance understanding of food labelling (Abeliotis, Lasaridi et al. 2014) and how to store food to prolong the lifetime. Graham-Rowe, Jessop et al. (2014) also emphasize that prevention initiatives should

- highlight benefits such as financial savings
- emphasize that prevention is the “right” thing to do
- involve consumers in the barriers by addressing issues as denial of responsibility and the consumers' inner conflicts between wanting to be the good provider and wishing to reduce food waste

Public awareness campaigns aim at affecting the behavior of the individuals, but as described in section 5.1.4.2 there are limits as to what individuals can do to solve the environmental challenges related to waste. Barr, Guilbert et al. (2013) along with Fell, Cox et al. (2010) advocate for the need for harder measures, both fiscal and regulatory, but they do not elaborate more specifically how this should be effectuated.

In table 5.5, we derive from the literature suggestions and recommendations in relation to the management and planning of prevention initiatives in the context of LWM. They range from specific suggestions to prevention initiatives to overall recommendations to the planning process.

Table 5.5: List of waste prevention measures that could be incorporated in the Local Waste Management

Waste prevention measures, instruments and initiatives	
Domain	Examples
Planning WP (Zorpas, Lasaridi et al. 2015, Cox, Giorgi et al. 2010, Phillips, Tudor et al. 2011, Thyberg, Tonjes 2015)	- Leadership, - improve organizational capacities, increase knowledge - Setting specific reduction targets for the residual waste - Base the plan on reliable data and area specific features of the waste, compositional analysis - Data collection, performance evaluation - Continuingly review and improve - Stakeholder engagement - Communication and outreach - Zero Waste Places - Link to other initiatives
Campaigns (Williams, Schneider et al. 2015; Zorpas et al., 2015; Cox et al. 2010) (Phillips et al. 2011)	- Distinguish between prevention and recycling (drivers for sorting behavior and prevention behaviors are different) - Address the variety of practices of which waste is a result (shopping, cooking, storing of food etc.) - Focus on one specific waste stream, and/or specific behaviors - Stimulate general environmental attitudes, enhance environmental values - Articulation of the consumer conflicts - Provide skill-building, tangible tools to reduce waste - Cookbook for leftovers - Training sessions in schools - Meetings and conferences with stakeholders - Cloth-nappy schemes (Bulkeley, Gregson et al., 2009)
Food waste campaigns (Graham-Rowe, Jessop et al. 2014, Evans 2011, 2012)	- Target “waste concerns” - Highlight the benefits of FWP, such as financial rewards - Emphasize that reducing is the “right” thing to do (social responsibility, ethics) - Involve consumers in the barriers by addressing difficult issues - Empower people: skill building, e.g. storage food correctly, cook with leftovers
Other (Evans, 2011)	- Interventions in the ways food is provisioned, e.g. changes in packaging sizes, types and materials.

5.1.4.7 Reuse

Reuse is a part of the definition of prevention, but initiatives for reuse are very different than those encouraging strict avoidance of waste. There is a waste prevention potential in creating structures or instruments that can spur and enable reuse (Bulkeley, Gregson 2009). Reuse of consumer products is moreover by several authors considered to have unutilized potential to prevent waste (Kissling, Fitzpatrick et al. 2012, Fell, Cox et al. 2010, Gelbmann, Hammerl 2015, Bulkeley, Gregson 2009). The cause is an excess of products in developed societies due to increased consumption. Since slowing down consumption does not seem to be an option (Bulkeley, Gregson 2009), the focus should be on diverting products and materials away from the waste stream and to keep them longer in use.

One particular product group has received more attention in the reuse literature, and that is electrical and electronic equipment (eee) (Kissling, Fitzpatrick et al. 2012, Kissling, Coughlan et al. 2013, Ongondo, Williams et al. 2013, Curran, Williams 2010). Due to high replacement rates of eee products among consumers, there has been an increase in both 'unwanted surplus items' and waste electronic and electrical equipment (WEEE). WEEE is regulated by the WEEE Directive, and this means that once collected by a LWM, the used products are classified as waste and sent to treatment, e.g. recycling. In this regard, the existing WEEE system can be regarded as an institutional lock-in hindering reuse. Ongondo, Williams et al. (2013) suggest development of a filtering mechanism to sort out reusable WEEE from the waste stream in order to increase the supply of used products and to reduce the amounts of waste. Other similar measures can be taken to increase the supply of other types of used consumer goods.

There may be a discrepancy between supply and demand. In New York, Fortuna, Diyamandoglu (2015) report on too low demand, whereas Gelbmann and Hammerl (2015) report that the demand for second-hand goods exceed the supply in their Austrian case. According to Kissling, Coughlan et al. (2013), a frequent barrier to reuse shops is that both supply and demand fluctuate. There are thus challenges related to both increasing supply and demand and to balancing the two. Fortuna, Diyamandoglu (2015) suggest an outreach to possible recipients of products, such as schools or homeless people. The key is to *encourage* and *enable* individuals to choose used products over new ones (Cox, Giorgi et al. 2010) by making it easy and convenient, for instance by facilitating reuse/swap shops in the neighborhood or at the local waste collection site (Bulkeley, Gregson 2009). Kissling, Coughlan et al. (2013) present the brilliant term *value conserving logistics*, which covers considerations and actions taken to protect the value of used product during collection and storage.

It can be difficult to maintain an economically viable business on reused products. Hence, much reuse occur in the third sector as social enterprises, mostly non-profit

with social goals (Kissling, Fitzpatrick et al. 2012). Curran, Williams (2010) points out that in the UK these social enterprises and the LWMs are not well integrated, entailing a loss of reusable products which are instead disposed as waste. Partnerships between LWMs and social enterprises are thus highlighted as a means to increase reuse (Curran, Williams 2010, Ongondo, Williams et al. 2013, Alexander, Smaje 2008). Additionally, employment of people who are currently outside the labour market in flexible job positions can reduce labour cost as well as fulfilling a social function of educating and reintegrating people to the labour market (Gelbmann, Hammerl 2015, Curran, Williams 2010).

In table 5.6, we derive from the literature suggestions and recommendations to organize reuse in the context of LWM.

Table 5.6: List of different measures and recommendations for Local Waste Managers to enable reuse

Measures to increase local Reuse as part of a WP strategy	
Reuse shops/facilities Bulkeley, Gregson et al., 2009 Gelbmann, Hammerl 2015 Curran & Williams, 2010	- Development of neighbourhood-based or community-based “not for profit” reuse/bring/collection facilities - Swap shops - Establishment of “reuse parks” clustering reuse activities - Install “reuse-corners” in community waste centres - Establish partnerships between LWM and social enterprises
Increase supply of second-hand goods Bulkeley, Gregson et al., 2009 Ongondo, Williams et al., 2013 (Hibbert, Horne et al. 2005)	- Service for home moves and house clearance (to collect reusable items) - Application of a filtering mechanism to sort reusable products from the WEEE stream - Engagement in partnerships with social enterprises - Reuse organizations collect bulky waste on behalf of LWMs - Use traditional disposal channels

Create demand Fortuna and Diyamandoglu, 2015 Kissling, 2013 (Gelbmann, Hammerl 2015)	- The presence of a facilitator brokering of managing reuse exchanges - Outreach to potential recipients of surplus items, e.g. schools and homeless shelters - Find end-users with a high and continuous demand for waste materials - Low pricing of second-hand products - Marketing
Repair Ongondo, Williams et al., 2013	- Increase expertise in organization to repair products
Quality Ongondo, Williams et al., 2013 Kissling 2013	- Careful collection of used products to maintain reuse potential - Ensure quality standards for refurbished products - Quality-guarantee - Value conserving logistics - Transparency of process
Labour/social sustainability Ongondo, Williams et al., 2013 Curran & Williams, 2010	- Take in individuals/labour from rehabilitation schemes – engage collaboration/partnerships with job centers - LWMs not just focus on tonnages and cost-effectiveness, but also on positive social value and benefits

5.1.5. DISCUSSION AND CONCLUSION

In the analysis, we found some distinctive features of particular relevance to the inclusion of waste prevention in the local waste management. A minority of the recent research on waste prevention specifically aim at informing local waste management. Hence, a partial purpose of this literature review has been to extract knowledge of waste prevention relevant for waste managers. This also contributes to appointment of directions for future research.

Our first set of suggestions regard how knowledge on waste prevention behavior can be used by LWMs to design waste preventing initiatives. Even though state-of-the-art literature on waste prevention behavior has developed greatly during the last decade, there are still unanswered questions. Among social practice researchers,

there seem to be consensus that it is too simplistic to view waste reductions as merely a question of individuals making better choices. Rather there is a need to change the structures in which practices related to waste prevention occur. Both Evans (2011) and Bulkeley, Gregson (2009) advocate for waste prevention initiatives that target the social conditions in which waste is produced rather than only conceptualizing waste generation as a problem of the individual's behavior. The implications of this for LWMs are that, regardless of how well campaigns are put together, there are limits to how much individuals can do to reduce waste. Waste prevention campaigns can certainly be suitable and current state of the art research present valuable input to design prevention campaigns. What lacks is knowledge on how to design waste management infrastructures in ways that encourage households to produce less waste. The literature presents some recommendations, but they mainly regard enablement of reuse of consumer goods. But reuse does not reduce the daily household discard. The only recommendation regarding reduction of household discard through structural changes concerns economic charging systems. These have proven to be counterproductive, because they displace waste rather than reduce it (Bulkeley, Gregson 2009). For this reason, we welcome future research on how/if waste management systems can be designed to spur reductions of waste in households. This could include other types of economic incentives, bin size, collection frequency or other structural features related to the waste management system.

Our second point regards the methodological approaches that might be applied to studies such as the ones suggested above. Much research on waste prevention behavior among citizens use questionnaires. Questionnaire surveys are suitable for collecting information from a large sample of the population. Nevertheless, we urge caution in the use of questionnaires with self-reported behavior. This is due to the tendency of respondents to present themselves and their actions better than they actually are (as discussed in section 5.1.4.2).

Case study methodology is obviously well suited to investigate how LWMs could transcend traditional waste management and include initiatives for prevention. This is due to the transdisciplinary nature of the subject. In the design of future case studies, we suggest specific attention be paid to monitoring methods of specific types of initiatives. The reason for this is that in a majority of recent case studies it has not been possible to reliably determine the correlations between cause and effect. Too many measures have been initiated simultaneously to determine which one(s) had which effect. Sharp et al. (2010a) argue that it is the accumulation of initiatives, which resulted in the documented waste reductions. But if so, this could be investigated for further understanding of why and how.

Reuse is principally the second best solution in the waste hierarchy and is covered by the definition of waste prevention. However, it is unclear what the environmental effects of reuse actually are, because second-hand products do not replace new

products one-to-one. Defining the system boundaries of reuse, is the largest challenge to determining the effects of reuse, but if reuse is to be prioritized there may be a need for more specific assessments of the environmental effects. Hence, we encourage well-designed assessment studies on the environmental effects of reuse. Moreover, there are uncertainties about the legal aspects of how reuse can become a part of local waste management. Once defined as waste, products can no longer legally be reintroduced to the market. How this barrier can be overcome, will also need to be investigated by future studies.

Our third point regards the significance of local characteristics in incorporating waste prevention measures in the local waste management. The potential of waste prevention measures depend on local characteristics. This includes the composition of the waste (Zorpas, Lasaridi et al. 2015) and the level of advancement of the local waste management system (Gentil, Gallo et al. 2011). The more advanced the waste management system is, the less the environmental improvement potential of the waste reductions will be for the waste management system (Gentil, Gallo et al. 2011). Moreover, we would argue that the more advanced the waste management system is, the more difficult it may be to incorporate waste prevention measures into the system. We base this argument on the findings of Unruh (2002) Corvellec, Zapata Campos et al. (2013) and Wilts (2012) who found that existing infrastructures and systems, even if built on a sustainability record, may in time impede the implementation of more sustainable solutions. For instance, it is argued that Scandinavian waste management is locked to incineration due to previous large investments in this type of technology (for more details see Corvellec, Zapata Campos et al, 2013). Incineration plants, but also other types of treatment technology, are dimensioned according to existing amounts of waste. This incentivizes LWMs to maintain household waste production at the levels upon which the treatment capacity was initially based. These investments may thus remove the incentives to reduce waste. Contrarily, in localities with landfill as the dominant waste solution, the possibilities may be better for incorporating prevention in the initial phases of the development of a more sustainable waste management system. Illustratively speaking, there is reason to believe that it is more difficult to ascend the waste hierarchy, that is, move from incineration to recycling, and then to reuse and prevention, than to start at the top and prioritize prevention from the beginning. Future research on incorporation of prevention in the local waste management should thus take local characteristics into account.

Finally, there needs to be coherence in the regulative waste framework. Currently, EU member states are obliged to increase recycling targets to 50 % of all household waste. Setting quantitative targets is important for a successful implementation. However, quantitative targets for prevention lack in most member states. Quantitative targets are more binding than softer declarations of intent, and this may have the effect that recycling will be prioritized over prevention in the practical

implementation in the member states. Whether the quantitative recycling targets in the EU affects prevention negatively is another theme for further investigation.

Our aim with this paper was firstly to provide LWMs with knowledge relevant for the incorporation of waste prevention into the local waste planning. Secondly, it was to elucidate strengths and weaknesses in the current literature and point towards future research topics. Viewing waste prevention through these lenses delimitates our focus and consequently our findings. For instance, it can be argued that our deselection of the meaning and significance of national policy instruments gives a too narrow view on instruments to prevent waste. Moreover, it can be discussed if our geographical delimitation is sensible given the large differences there are in waste management systems in the developed world. Practitioners and scientists in developing parts of the world may find our findings useful, and likewise we may have overlooked valuable insights from other parts of the world. Finally, our categorization of the literature could have been different, for instance by sorting out literature on de-coupling. However, we expect that waste prevention literature will develop in the coming years, and new perspectives on the subject will emerge.

CHAPTER 6. SYSTEMIC PERSPECTIVES ON THE INTEGRATION OF 'PREPARE FOR REUSE' AS A WASTE MANAGEMENT SOLUTION

Enabling citizens to reuse post-consumer products (durable and non-durable goods that enter the waste streams) was in the previous chapters identified as a way for a waste management company to work with waste prevention (chapter 5) and as a focus point for circular business model innovation (chapter 4). Preparing post-consumer products for reuse through refurbishment and remanufacturing processes is not an integrated part of AVVs waste management practices, nor is it commonly conducted in other parts of the waste management system.

In this chapter, I investigate the potentials and barriers for preparation for reuse to become an integrated part of the of the Danish waste management system supplementary⁶ to other treatment option. I do this by investigating barriers and possibilities firstly from a systems perspective and secondly from a niche perspective in AVV.

Developing solutions for reuse requires that waste managers change their focus from cost-effectiveness in collection and management to a focus on value creation from waste (Stahel, 2016). However, such as shift in focus may disturb the balance of responsibilities and benefits among the stakeholders in the system. As suggested by Shove & Walker (2007: 765) it is important to investigate “*who wins and who loses out as transitions are guided in one direction but not another*”. Preparation for reuse conducted by municipal waste management companies has been a subject of political dispute. The Confederation of Danish Industry has strongly opposed it with the argument that if waste is to be prepared for reuse, this should be conducted by private enterprises not public (Dansk Industri, 2015). This has raised questions of whether there even is a business case for preparing for reuse waste from the

⁶ I chose to suggest preparation for reuse as a supplementary waste management option to other treatment solutions, i.e. recycling, incineration and final disposal. This is because perpetuate cycles is an illusion. Preparing post-consumer products for reuse postpones the time where the product will be so obsolete that it will be beyond value as a product or as holding components for new products. Eventually, the value of the product will be so low that material and energy recovery will be the preferable solutions.

municipal collection sites. And if the value of the waste is too low for making a viable commercially driven business on it, should municipalities then be allowed to finance preparation for reuse activities and reuse shops through the citizen fees in a similar way as other waste treatment solutions are financed?

There is one post-consumer product group, which is particularly problematic with regards to conflicting stakeholder interests in preparation for reuse, and that is waste electrical and electronic equipment (WEEE). WEEE is moreover a waste type that is particularly environmentally problematic due to its content of hazardous substances, use of critical raw materials and energy consumption during use phase (EU, 2012). This means that from an environmental perspective, there could be benefits from prolonging the life of EEE, but the multiple stakeholder interests in this waste type has so far hindered its reuse. One way of changing the WEEE management system could be through government imposed rules and regulations pushing for more prepare for reuse, but another way is a bottom-up approach at niche level, where experimentation in protected spaces with preparing WEEE for reuse can provide practical learnings to be used as building blocks for a larger systemic change (Schot & Geels, 2008). However, in order to pursue the latter strategy, a thorough understanding of challenges at systemic level is useful. Understanding who the relevant stakeholders are, and what their interests are can be key to engaging the right stakeholder collaborations which are repeatedly emphasized in literature as crucial for successful niche level experimentation (Schot & Geels, 2008) as well as for circular business model innovation (Kraaijenhagen, van Oppen, & Bocken, 2016).

Therefore, the first part of this chapter deals with the challenge of understanding the socio-technical system within which a new waste management solution, i.e. preparation for reuse of WEEE, are to be integrated. In this part, I map the Danish WEEE management system and investigate the interests of the major stakeholder groups, in order to identify constraints and opportunities of preparation for reuse. This part is presented in the research article *“Socio-technical perspectives on the Danish WEEE management system: Investigating constraints and opportunities for integration of “preparation for reuse” as a management solution”*.

Subsequently, I describe the process that has taken place in AVV to develop activities for preparing WEEE for reuse, and how and why some changes in the framing of the visions may be necessary for these experiments to entail the benefits that strategic niche experiments can have on regime level change. Thus, the development of a solution for enabling reuse of WEEE is an example of how and why a change in the socio-technical system can develop through dynamics between the local context and the larger socio-technical system.

6.1.1. WEEE AS A CASE STUDY OF PREPARATION FOR REUSE

Before presenting the results, a few notes on WEEE as a case study should be given. Yin (2009) writes that a case study “*investigates a contemporary phenomenon in depth and within its real-life context*”. I chose a case study approach in order to address the fact that each waste fraction is managed within its own sub-system of the socio-technical system of waste management and thus involves particular stakeholders, technological and institutional settings. Moreover, waste types differ in terms of potential reuse benefits, i.e. environmental benefits, social equity and well-being benefits and economic creation potentials. WEEE is highlighted as holding a high potential reuse value due to the inherent technological value in the products, which are higher than the material value that could have been recovered through recycling (Macarthur, 2013; MacArthur Foundation, 2015; Parajuly & Wenzel, 2017). In addition to the supposedly positive effects from reuse, WEEE is also governed differently than other waste types, and a specific system has been set up for the management of WEEE. These factors could make WEEE an extreme case compared to other waste fractions. Moreover, the before mentioned dispute about reuse shops in municipalities has had a particular focus on WEEE, and industry networks have strongly opposed the reuse of WEEE (Dansk Industri, 2015). For this reason, WEEE may also be the least likely waste type to be reused within the current Danish waste management system. Operating with “least likely” or extreme cases can maximize the utility of information that we can gain from a case (Flyvbjerg, 2006). This could mean that if AVV can succeed in developing and organizing prepare-for-reuse activities on WEEE, then other waste authorities or private businesses in Denmark would also be able to succeed in this. In either case, a niche experimentation with preparation of WEEE for reuse can provide learnings at multiple dimensions, such as regarding market and user preferences, infrastructure and maintenance networks, industry and production networks, regulations and government policy and societal and environmental effects (inspired by Schot & Geels, (2008)).

6.2. ARTICLE B:

Title: “Socio-technical perspectives on the Danish WEEE management system: Investigating constraints and opportunities for integrating “preparation for reuse” as a management solution“

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Abstract

In Denmark, the targets of the WEEE Directive are primarily met through recycling, even though waste electronic and electrical equipment (WEEE) could be prepared for reuse with increased environmental, economic and social benefits. In this study, we investigate the WEEE management system as a socio-technical system. Through interviews with 23 stakeholders in the system we identify conflicts of interest and technological, organizational and institutional constraints for integrating “preparation for reuse” as a management option within the current system. Based on this, we identify four main prerequisites for a future integration of preparation for reuse. These are: a) extended tendering periods to incentivize technological investments; b) the introduction of measures to incentivize municipal waste authorities to organize value-conserving logistics; c) the introduction of standards and/or guidelines to ensure the quality and safety of preparation operations and data management; d) measures to avoid transboundary sales of used EEE. Based on transition management theory, we suggest pilot testing and the development of niche projects to test new constellations of collaboration between actors in the system.

Key words: “preparation for reuse”, WEEE, waste management, stakeholder analysis, socio-technical system

6.2.1. INTRODUCTION

The concept of the circular economy (CE) is an umbrella concept for new ways to organize reuse and recycling (Blomsma & Brennan, 2017). One of the principles of the CE is that the lifetime of products should be as long as possible before materials are recovered from waste products through recycling (Nancy M. P. Bocken, de Pauw, Bakker, & van der Grinten, 2016; Macarthur, 2013). Prolonging the lifetime of discarded products can be enabled through preparation for reuse activities. Preparation for reuse can be defined as “...*checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be reused without any other pre-processing*” (EU 2008). This definition implies that preparation for reuse (PfR) can be conducted by actors other than the original owner. One of the great ideas within contemporary conceptualizations of the CE is that the original equipment manufacturer (OEM) should take responsibility for the afterlife of their products by taking them back and preparing them for reuse (Macarthur, 2013). For electronic and electrical equipment (EEE) a regulatory framework, the WEEE Directive, was developed to incentivize such take-backs. In practice, however, individual producer responsibility and product take-back is a rarity, and the vast majority of WEEE is collected by waste managers and treated for recycling (Grunow & Gobbi 2009). Consequently, almost no preparation for reuse takes place in the current waste management system. This is despite the fact that the potential for reuse of household WEEE has been assessed as being significant (Bovea et al. 2016; Parajuly & Wenzel 2017).

Efficient resource management of WEEE is of high priority due to its increasing volumes, high value and hazardous contents (Achillas, Moussiopoulos, Karagiannidis, Vlachokostas, & Baniyas, 2010). There are well-documented environmental benefits from recycling (Bigum et al. 2012, Hirschier et al. 2005, Wäger & Hirschier 2015), but the environmental benefits from the reuse of WEEE have been investigated less. A few studies on specific products document the benefits of a prolonged lifetime (Lu et al. 2014, 2015, Prakach et al. 2012, Truttmann & Rechberger 2006, WRAP 2011, Zanghelini et al. 2014). However, the reuse of end-of-life products may additionally have other types of benefits: economic potentials are documented by Parajuly and Wenzel (2017) and WRAP (2011), and in particular the social benefits seem to justify increased reuse of waste products. Social benefits include employment opportunities, training for low-skilled labor and providing less advantaged people in the local community with the opportunity to acquire products to increase their standards of living (Curran & Williams 2010).

In order to achieve a circular economy and reap environmental, economic and social benefits, it is essential that different end-of-life treatment solutions coexist. In the WEEE management system, this implies that reuse should be able to coexist with recycling, incineration and safe disposal if needed. Currently, this is not the case.

The aim of this study, therefore, is to identify and analyse constraints, prerequisites and opportunities for the integration of preparation for reuse in the current WEEE management system in Denmark. Unlike previous studies, the article takes a socio-technical perspective on the WEEE management system in order to identify constraints and opportunities for PfR within the interaction between human practices and infrastructures and technology. The article focuses on the relationship between physical waste infrastructures, actor constellations in the current waste governance and the incentives for reuse of WEEE. Mapping and analysing this can point to opportunities to integrate PfR into the system.

Socio-technical systems are developed and optimized with regard to their societal function. The societal function of the existing WEEE management system is formally, as stated in the WEEE Directive:

...to contribute to a sustainable production and consumption by, as a first priority, the prevention of WEEE, and, in addition, by the reuse, recycling and other forms of recovery of such wastes...” (EU 2012).

However, in practice, this order of priority (reuse over recycling) does not appear to be the guiding principle. In practice, the aim of the current system is to collect and manage WEEE for recycling.

6.2.1.1 Theoretical background

Socio-technical systems can become so well established that they hinder the emergence of alternative, more sustainable solutions (Kemp, Schot, & Hoogma, 1998). Technological development follows a path influenced by a number of factors such as the existing market, the institutional and regulatory framework, economic rules and contracts, and the expectations of the users of the technology (David 1985, Foxon 2002, Kemp et al. 1998). Social factors can also become constraints, for instance through adaptation of preferences and expectations, codes of behaviour and social conventions (Unruh 2002). These factors tend to favour existing technologies over new ones. Path dependencies already exist in the current waste management regime as documented by Wilts (2012) and Corvellec et al. (2013). The existing treatment of waste has minimized the direct environmental impacts from waste and this has reduced the pressure to implement more sustainable solutions such as PfR.

Path dependencies favour one solution over others due to a self-reinforcing feedback that relates to the technological, organizational, institutional and social systems. This can lead to constraints that limit the capability of change. The concept of path dependency frames how constraints due to choices in the past influence present decisions (Unruh 2002).

Changing systems, such as integrating PfR into the WEEE management system, may thus involve changes in technology, infrastructure, governance and institutions, as well as business and social dynamics, culture and knowledge (Geels, 2011). Moreover, a change requires a systematic promotion of alternatives – a social or political recognition of the need for intervention (Corvellec et al., 2013).

6.2.2. MATERIALS AND METHODS

As the study aims to investigate constraints and opportunities for integrating PfR in the current socio-technical system of WEEE management in Denmark, the first step is to identify the basic constituent elements of the system. This includes institutional elements such as the regulatory framework for WEEE management, stakeholders in the system and the technological set-up of the system. The first step of our analysis is thus to map the major stakeholder groups of the system. Previous research on the implementation of the WEEE system in Denmark is limited. We therefore develop our own approach to identifying the actors involved and to understanding the perspectives on reuse that each of these actors experience. The mapping is conducted through document analysis and in collaboration with WEEE officers from the Danish Environmental Protection Agency (EPA). We select the respondents using a combination of informed and snowball sampling (Biernacki & Waldorf 1981). The criteria for selecting the stakeholders to be included in the further investigation are that they should:

- Be involved in the current WEEE system in Denmark and have a “stake” in it;
- Benefit from the current system and/or potentially benefit from increased reuse of WEEE.

In Table 6.1, the stakeholder groups are displayed along with the number of interviewees in each stakeholder group. There are differences as to the extent to which the interviewees are representative of their stakeholder group. The interviewed collective schemes cover more than 80% of the market, whereas the two producers cover a miniscule part of the market.

Table 6.4 Stakeholders in the Danish WEEE management system who were interviewed for the study

Stakeholder group (interview respondent)	Number of respondents
Treatment/recycling industry	6
Collective schemes and the organizing body	3 (covering 80% of the market)
Municipalities and municipal solid waste management companies	4
Producers (of EEE)	2
Refurbishers	2
NGOs/charity organizations operating reuse shops	3
Retailers of EEE	3

A final stakeholder group constitutes potential consumers of used EEE. This group comprises the market for the products prepared for reuse. Their interests and willingness to pay are essential for the success of a future PfR. In order to uncover their interest in used EEE, an email interview was conducted with eBay.

6.2.2.1 Interviews

Within each actor group, representatives were chosen for interviews to investigate the group's interests in, and perspectives on, possible future governmental support for increased reuse. We aimed to interview at least two actors from each group, preferably the most influential or dominating actor in the category.

Twenty-three semi-structured interviews were performed with different stakeholders. We chose semi-structured interviews in order to gain qualitative insight into each stakeholder's tasks and position on the subject (Kvale & Brinkmann, 2015). The interview guide was aimed at covering the following themes:

- role and tasks within the current system
- economic interests and investments in the system (if possible)
- relations and cooperation if any with other stakeholders in the system
 - o how these relations are organized
- whether or not they currently conduct or are in any way involved in preparation for reuse
- opinions about actors who currently conduct informal PfR (support or resist?)

- interest in, and perceptions of, the possibility of incorporating PfR into their own processes or other areas of the current WEEE management system
 - o interest in getting access to the collected WEEE at household waste recycling centres (HWRCs)
 - o business opportunities?
 - o potential conflicts?
- perception of constraints
- view on which actors could be responsible for conducting PfR in a future system
- which conditions and prerequisites should be met for them to support future PfR

Not all questions were meaningful for all stakeholders. For instance, charity reuse shops do not report any WEEE data and thus have no insight into the issues related to data collection and management. Similarly, producers were the only ones that could meaningfully be asked about whether they would consider changing the design of products to support PfR better. Thus, there were slight differences in the questions asked. The interviews were conducted in 2014 and the beginning of 2015 and each lasted approximately half an hour. Thorough notes were taken during the interviews.

Interviews with the actors are our main data source, but document reviews also play a role. These sources have enabled us to analyse the complex interactions around the WEEE management in Denmark and to identify suitable actors for the interviews. As a complementary data source, we also include observations from a waste industry conference regarding the future of the WEEE system, where the interests of the various stakeholders were discussed. Attending the conference gave insights into more than just single stakeholders and their interests. Here, we observed how the actors interacted with each other, how different actors reacted to expressions from other actors and what gave rise to discussions. These observations have significantly increased our understanding of the issues involved.

6.2.2.2 Delimitations and assumptions

The study is delimited to include WEEE from households covering large and small household appliances, IT and telecommunication equipment, consumer equipment, lighting equipment, electrical and electronic tools and toys, and leisure and sports equipment. Hence, not all the categories of the WEEE Directive are included. Moreover, the study only covers WEEE collected through the formal collection system.

6.2.2.3 Collection of background knowledge

An initial review of how WEEE PfR and reuse coexist with WEEE recycling in other European countries was carried out in order to collect experiences that may serve as inspiration for potential future changes in the set-up in Denmark. A review was conducted of peer-reviewed and grey literature on the reuse of WEEE in European countries based on a search of Science Direct, Scopus and Google with the key words “reuse”, “WEEE”, “Waste management” and “Waste prevention” in various combinations. Grey literature was included partly due to the limited research in the field, but also in order to capture information from other sources such as the websites of reuse shops and waste management and governmental strategies for WEEE reuse in other countries. After identifying countries/locations with high reuse rates, the authors went on a study trip to Brussels (Flanders) and London. Here we made observations and conducted interviews with governmental officers, representatives from the recycling industry, reuse organizations, and practitioners from local waste management authorities and socio-economic enterprises. This initial investigation serves as a background for the interview guide and for the suggestions presented in the analysis and results section.

6.2.3. THE DANISH WEEE MANAGEMENT SYSTEM

The WEEE management system is a socio-technical system, i.e. a system in which people interact with technology to achieve a certain purpose. The system thus consists of a number of stakeholders, each with their own interests, an institutional framework, technologies for collection and treatment, and the practices and actions knitting these factors together.

6.2.3.1 The regulatory framework as an element in the socio-technical system

Institutional factors such as regulation set the frame for the system. The WEEE management system is governed by the WEEE Directive. The WEEE Directive aims to prevent the generation of WEEE and to encourage reuse, recycling and other types of recovery (EU, 2003). By introducing producer responsibility, the Directive made the producers (or importers) of EEE responsible for handling the waste. The initial idea was that the producer responsibility would give the producers an incentive to design EEE with the end-of-life phase in mind. The producers could then handle this responsibility individually or by joining collective schemes (Grunow & Gobbi 2009). The practical outcome was that the majority of the producers joined collective schemes to organize the management of the WEEE (Lauridsen & Jørgensen 2010). Though not pushing product innovation as intended, the current system has been rather successful in terms of collecting the WEEE for treatment (see Figure 6.2 for collection rates in the EU member states). In 2015, 12.3 kg of waste per capita was collected (Eurostat, 2017b). Therefore, Denmark is one

of the countries with the highest collection rates and performs much better than the regulatory minimum collection target of 4 kg per capita a year.

The Directive also prescribes that PfR should be conducted. In 2012, the WEEE Directive was revised and a stronger emphasis on PfR was introduced. Table 6.2 presents the more specific decisions concerning reuse. These revisions were implemented into Danish legislation through WEEE Statutory Order no. 130 (Miljøministeriet 2014).

Table 6.2 Articles in the WEEE Directive that emphasize preparation for reuse and thus challenge the current implementation of the Directive in Denmark

Articles in the WEEE Directive that emphasize reuse-related clauses	
<i>Preface (20)</i>	<i>“Where appropriate, priority should be given to preparing for reuse of WEEE and its components”</i>
<i>Art. 5 Separate Collection</i>	<i>“Member states may require that the WEEE deposited at collection facilities ... is handed over to producers or third parties ... for purposes of preparing for reuse...”</i>
<i>Art. 6 Disposal and transport of collected WEEE</i>	<i>“...the collection and transport of separately collected WEEE is carried out in a way that allows optimal conditions for preparing for reuse, recycling...”</i> <i>“In order to maximize preparing for reuse, member states shall promote that, prior to any further transfer, collection schemes or facilities provide, where appropriate, for the separation at the collection points of WEEE that is to be prepared for reuse from other separately collected WEEE, in particular by granting access to personnel from reuse centres.”</i>
<i>Art. 14 Information for users</i>	Information for citizens about their role in enabling reuse of WEEE

Though emphasizing PfR, the wording of the Directive is rather vague. Clearly, it is up to the individual member states to decide how PfR is to be organized and who should have access to the WEEE. Furthermore, there are no specific targets for PfR. Instead, PfR is an integrated part of the recycling targets.

6.2.3.2 Actors and their organization in the system

The Danish implementation of the WEEE Directive resulted in a centralization of the WEEE system (Danish Producer Responsibility 2014). Before the implementation, local authorities were responsible for both the collection and treatment of WEEE from the households in their area (Danish Producer Responsibility 2014). After the implementation, the local authorities are only responsible for the collection and separation of WEEE. Citizens discard their used EEE at municipality-owned HWRCs. The municipal HWRC is the most commonly used destination for waste disposal in Denmark. At these sites, a demarcated area is set aside with cages for the collection of WEEE in five fractions. The producers are responsible for making the collection equipment available (Danish Producer Responsibility 2014, Miljøministeriet 2010). Carriers pick up the collected WEEE and transport it to the recyclers, who process it and send it abroad for further recycling. The recyclers typically carry out some treatment of the WEEE, before it goes to the market for secondary raw materials. The Danish Producer Responsibility (DPA) is administering the Danish implementation of the WEEE Directive that reports to the Danish Environmental Protection Agency (EPA). The system and actors are illustrated in Figure 6.1.

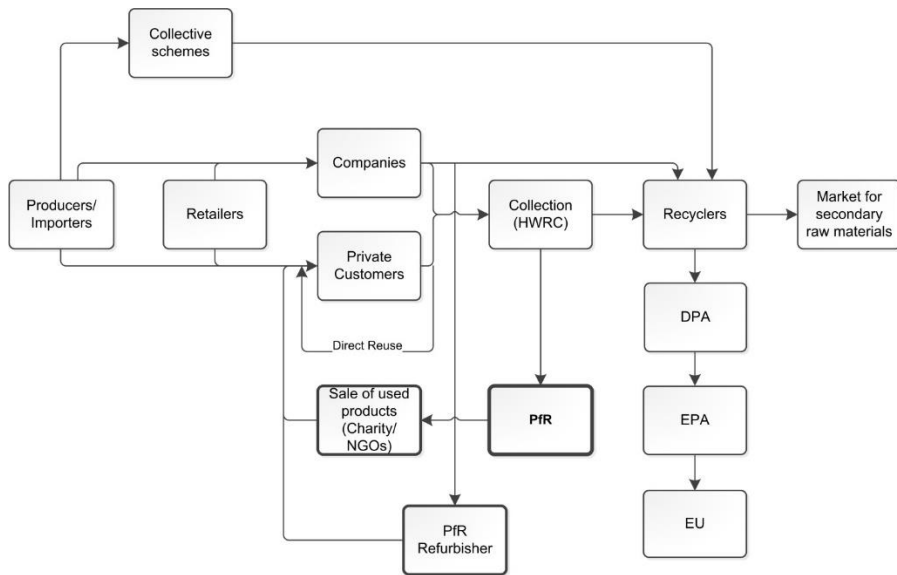


Figure 6.1 The socio-technical system of WEEE management in Denmark. Actors and flows of (W)EEE.

In practice, almost no producers have taken individual responsibility, i.e. no producers take back their own products and include these in new production (Grunow & Gobbi 2009). Instead, most producers are members of collective

schemes (privately owned companies) organizing and managing the end-of-life phase of the EEE products (Grunow & Gobbi 2009). According to interviews conducted for this study, this typically materializes through short-term contracts with private waste companies – the “recyclers” – who process WEEE for recycling. Usually, the WEEE is pre-processed mechanically using destructive methods combined with different sorting techniques and the resulting fractions are processed in high-standard refineries (Gmünder 2007). Denmark has no end-processing facilities and only a few pre-processing facilities (Pizzol et al. 2012). These facilities have invested in destructive disassembly technologies (Pizzol et al., 2012)

Apart from the basic actors of the WEEE management system, other stakeholders may also have an interest in future WEEE PfR models. The EEE reuse sector has been growing in recent decades (Kissling et al. 2012) and this sector has a stake in potential future WEEE PfR. The sector includes socio-economic enterprises selling second-hand products from consumers to individual users for charitable purposes. This type of reuse operating model was also identified by Kissling et al. (2012). In Denmark, another reuse operating model also exists: some municipal HWRC-run reuse shops that sell used products that are too good to be discarded. These municipal reuse shops are only viable because they employ people with special needs who may otherwise have been dependent on social services. In the reuse sector, refurbishers are private companies that repair and refurbish used IT equipment for resale. These are similar to the IT Asset Management Model discussed by Kissling et al. (EU 2008, 2012).

6.2.3.3 International PfR experiences

The WEEE Directive applies to all member states in the EU, but different models still exist among member states. The United Kingdom and Flanders (Belgium) are the European member states with the highest rates of WEEE reuse. These two countries reuse 0.6 kg per capita (UK) and 0.5 kg per capita (B) (Eurostat, 2013). The ways in which PfR is implemented in the two countries are very different, but for both, some distinctive features differ significantly from the Danish system.

The British Ministry for Business Innovation and Skills requires that the producers/collective schemes prioritize reuse and, as a result, collective schemes include reuse in their collection targets. Moreover, different types of collaboration and partnerships exist; for instance, some socio-economic enterprises collect WEEE for the collective schemes in order to prepare it for reuse.

In Flanders, the political vision is to link environmental policy (including reuse) with socio-economic policy. In practice, this means that targets are not only set for WEEE collection rates, but also for the number of social jobs in the reuse sector. They emphasize five success factors for their reuse of WEEE: a reuse standard (Code of Good Practice); a labelling scheme (Revisie); a common brand (De

Kringwinkel); collaboration with the collective scheme; and economic support for the reuse centres.

6.2.4. CONSTRAINTS FOR PREPARATION FOR REUSE AND STAKEHOLDER INTERESTS

The overarching question for this analysis is what constraints and opportunities there are for integrating PfR into the WEEE management system. By taking a socio-technical perspective on this, we identify and analyse technological, organizational, institutional and social constraints and opportunities. Additionally, we clarify stakeholder interests and relations. However, there is not always a clear distinction between the types of constraints, and stakeholder interests are dynamic and can change over time.

6.2.4.1 Technological constraints

The first constraint that we will point to relates to technological elements and sunk costs in the system. The main steps in the WEEE system are as described in Section 3.2.: (1) collection; (2) sorting, dismantling and preprocessing (including mechanical processes); and (3) end-processing (Schluep et al. 2009; Tanskanen & Takala 2006). The technology requirements and investment cost associated with the first two steps, collection and preprocessing, are considerably lower than the investment cost of the end-processing. Therefore, collection and preprocessing are typically carried out in a local/regional context, whereas the end-processing happens in a global context (Schluep et al. 2009). The few Danish preprocessing facilities have invested in destructive disassembly technologies (Pizzol et al. 2012) and this creates an incentive for the involved actors to maintain and increase recycling rates to achieve returns on this investment. The recycling industry depends on high and steadily flowing amounts of WEEE, especially high-value WEEE, in order to be able to recover the valuable materials and make a business of it. Firms are thus reluctant to invest in more sustainable alternatives due to the investments that they have made in existing technology (Foxon 2002). The current infrastructure is developed based on the attributes of this specific technological setting (Foxon 2002). This technological setting causes a ripple effect throughout the system, and as we will subsequently show, actors in the system have organized their practices to support this technology.

6.2.4.2 Organizational constraints

The recyclers are specialized in WEEE recycling processes and they serve a global market for secondary raw materials. The prevailing recycling treatment in Europe comprises a combination of shredding, and mechanical and manual sorting of the materials (Dalrymple et al. 2007, Williams 2006). This means that the physical conditions and functionality of the WEEE are of minor importance to the recycling process. There is no reason to protect the WEEE significantly from damages during

collection and transport. The response by the upstream actors has been to adapt to this feature of the recycling technology: at no stage of the collection process is the WEEE handled carefully; the consumers throw it into cages, where wind and weather can erode it; and the HWRC and logistics staff pack and transport the WEEE without consideration for the protection of the functionality and physical appearance of the products. Any reuse potential that may have been there before being discarded is destroyed or significantly decreased during the collection and logistics of the WEEE system. This social response of the consumers and the HWRC staff when handling WEEE has become routine. The routinized practices by actors in the system are one of the elements characterizing an organizational constraint. The collection system has been adapted to feed into the recycling technology, not to a PfR process, and this causes a lack of focus on conserving the reuse potential throughout the initial stages of collection and management of WEEE. All the interviewees emphasized this as a huge barrier to reuse.

The municipally operated HWRCs have no incentive to handle the WEEE carefully. This part of the collection system is not financed by the producer responsibility, but by the municipality through citizen fees. Hence, it is in the municipalities' interests to collect the WEEE as cost-effectively as possible. Collection that is more careful would require more labour and more trucks and equipment for careful transport.

The established logistics are not just an informal constraint to increased reuse, but, according to the respondents, they are even formalized as it appears in the tender document upon which the contracts between the collective schemes, logistics companies and municipal waste authorities are built. An interviewee from the recycling industry pointed out that some tender documents specifically require that no PfR occur. This is due to an attempt from the collective schemes to protect the interests of the producers. According to the interviewee, collective scheme sales of used EEE will cannibalize the sales of new products, thereby being contradictory to the producers' interests in selling more products that are new.

6.2.4.3 Institutional constraints

Institutional constraints include legal frameworks and policy intervention (Unruh 2002). Although the WEEE Directive in principle prepares the ground for increased PfR and reuse, there are also elements of the regulation that hamper the diffusion of PfR. The Directive gives the highest priority to prevention, then to PfR and thirdly to recycling. Nevertheless, recycling is the only solution for which specific targets are set. Specific recycling targets are binding, whereas the lack of targets for prevention and reuse may give the impression that these are optional. PfR is a treatment option within the domain of waste management, whereas reuse, including the reuse that takes place following a PfR process, can be considered a waste-preventing measure as it may hinder the acquisition of new products and delay the time at which the product becomes waste. This type of life cycle understanding is

not embedded in the current WEEE management system in Denmark. Moreover, the focus of traditional waste management is on cost-effectiveness in collection and treatment, not on creating value from waste (Stahel 2016).

The interviewees frequently expressed uncertainties about various aspects of the regulation. We consider this uncertainty to be a barrier to PfR. The uncertainties concerned rights and ownership of WEEE, consumer rights when selling used products (the Sales of Goods Act, guarantees and warranty rules) and product regulation (product safety and chemicals). Would it, for instance, be legal to sell a used electronic product that was originally produced before 2006 and thus did not comply with the RoHS Directive? Ambiguity and blurred policies can, according to Foxon (2002), become a lock-in mechanism. Thus, even if an actor in the current system had an interest in preparing WEEE for reuse, they might be reluctant to embark on it due to a vague and ambiguous current regulation.

The underlying reasons for the confusion concerning the regulation may be conflicting interests at the governmental level. On the one hand, there is an aim to reduce environmental impacts and increase sustainability through regulation, but on the other hand, there is pressure not to inhibit business opportunities and growth. Our interviews revealed a fear among some of the actors (particularly the collective schemes) that the sales of used products would affect the sales of new products negatively. Similarly, the Confederation of Danish Industry made a petition to the State Administration to prohibit PfR and reuse organized by public authorities (Confederation of Danish Industry 2015). Hence, governments may fear that regulation in favour of reuse would have a negative influence on the market. The paradox is that the environmental benefits of reuse can only be achieved if the used products replace new ones, but reuse replacing new products is anti-competitive. This puts policymakers in a dilemma, which locks the current system and places it on a trajectory away from reuse.

Moreover, WEEE management is governed by environmental regulation. Reuse is, however, largely legitimized by its social effects (Bovea et al. 2016, Curran et al. 2007). In Flanders, this has been overcome by placing waste regulation in the junction between environmental and social regulation. This demonstrates other ways to design the WEEE management system and shows that it is possible to promote PfR even under the current European policy framework despite its limitations.

6.2.4.4 Interests and incentives for performing PfR

If PfR is to be formally integrated into the WEEE management system, the question is: who should in practice conduct the PfR? Where in the system should PfR be organized? In principle, “reuse actors” who wish to prepare the WEEE for reuse should have access to the WEEE (Art. 6 of the WEEE directive), but according to the interviewees, no reuse actors have formally been given access to the WEEE at

the collection sites at the HWRCs. Some interviewees are unaware of the existence of this paragraph, while others think that this rule somehow does not apply to Denmark. In other words, uncertainty about rules and rights also plays a role in the matter of who gets access to the WEEE at the HWRC.

We asked each of the interviewed stakeholders if they were interested in getting access to the WEEE at the HWRC in order to prepare it for reuse. The interviewed refurbishers are not interested, as the WEEE collected at the HWRC is from households and is highly diverse in character and quality. According to them, this diversity hinders standardized procedures for PfR, and the workflows will become so inefficient that no viable business can be maintained. Moreover, they consider it too time-consuming to drive around to each HWRC to pick out and collect the reusable products. Thus, refurbishers are not necessarily part of a future solution for PfR.

The interviewed socio-economic enterprises are not a uniform group and do not have a common position on this matter. Some locally based charity reuse shops expressed an interest, but we also interviewed an NGO that prepares products for reuse in developing countries. They were highly aware of the challenges related to global reuse (as described by Williams et al. (2008)), and, due to their own quality standards, they were not interested in getting access. However, some locally based charity reuse shops could in a future system be part of the PfR process.

Likewise, the municipal waste authorities are not a uniform group in terms of their interest in preparing WEEE for reuse. Some municipalities run reuse centers in connection with the HWRC, and these are, according to the interviews, interested in getting access to WEEE. They see possibilities of creating (protected) jobs for unemployed low-skilled people currently receiving social security funds. These municipal waste managers value the ability to provide cheap products to disadvantaged people such as the unemployed and refugees. However, the municipalities without reuse shops at their HWRC have limited incentive to embark upon PfR. Being responsible for the collection, municipalities will play a vital role in potential future PfR processes regardless of who conducts the actual PfR.

The collective schemes organize and administer large parts of the WEEE system. They serve the producers' interest and aim to ensure that WEEE is collected and managed according to standards. Their support is vital for PfR. Yet, they express a number of concerns and prerequisites for PfR to be included in the system: they fear that PfR will not be performed correctly with sufficient consideration for quality, safety and data security. They fear that the WEEE will be sold outside the EU, where they can no longer guarantee the quality of the final waste treatment. They also fear negative effects on their reputation if WEEE is found to be transported to developing countries. These fears are legitimate and need to be considered carefully if PfR and reuse are to become an integrated part of the system. One of the

collective schemes expressed their willingness to be involved in developing the system with increased PfR, but the other interviewed collective scheme resisted it due to the cannibalizing effect that sales of used products might have on new products, as well as a concern regarding how reuse might affect producers' brands.

The recyclers' interest is, as described, in receiving as much high-value WEEE as possible. Some recyclers prepare screens and monitors for reuse, but on a minor scale. There was no common interest among recyclers in conducting PfR. A prerequisite for their support was that they would not receive less WEEE.

The interviewed producers showed no interest in PfR. However, neither did they articulate any particular concerns about PfR. They did not fear a cannibalizing effect, as they expected the market for used products to be low. However, we only interviewed three producers and thus cannot generalize producers' general perspective on the theme.

The interviewed retailers could become a part of a future PfR solution because they collect WEEE, particularly large household WEEE. The interviewed retailers, like the producers, did not hold any strong positions on the theme.

The Confederation of Danish Industry suggests that all potential future PfR is to be performed by private actors in order for it to operate on market terms.

To sum up, there is disagreement about who should have the right to perform PfR. At the same time, none of the actors as a uniform group perceives PfR as a particularly good business opportunity from a purely economic perspective. The actors who already run second-hand shops at local level would like to get access to the WEEE in order to prepare it for reuse in their local shops. These second-hand shops, whether they are socio-economic/charity or municipally driven, have in common that they are non-profit organizations and largely driven for social or environmental reasons, not just economic. The economic potential of WEEE, as assessed by Parajuly and Wenzel (2017) and WRAP (2011), is not evident to the stakeholders in the current Danish system and this may also be the reason that so few actors have made attempts to run businesses related to PfR.

Table 6.3 Technological, organizational and institutional constraints to PfR discovered through the interview analysis

Technological constraints	Investments in recycling facilities tie the actors to recycling - High interest in recycling of the most valuable parts of WEEE
Organizational Constraints	Collection and transport are designed to feed into recycling processes. Consequently, the reuse value of the WEEE is destroyed during collection and transport - Value-conserving collection and logistics are possible, but more costly. Uncertainty of who should pay
	Tendering documents prohibit PfR
Institutional constraints	Lack of clarity in regulation concerning - Which actors have the right to perform PfR - Rights and ownership of the collected WEEE - Consumer rights such as guarantee periods - Product regulation (e.g. RoHS)
	Conflicting interests among actors - Will a sale of used products cannibalize the sale of new products? - The most valuable parts of the WEEE are of interest to both recyclers and PfR actors
	Lack of financial incentives for PfR

The last stakeholder group, whose interest in reuse has not been covered yet, are consumers. Their support is vital for a future PfR solution, as they comprise the market for used products. Their interests were partly covered through the interviews: the interviewed actors who do sell used EEE report that the demand for used products is higher than the supply. Moreover, sale statistics from eBay show that an increasing amount of used EEE is sold on their consumer-to-consumer market platform. This indicates that the reuse of EEE is widely accepted among consumers. Hence, the introduction of PfR into the current WEEE system may not be constrained by social preferences. The public opinion is considered by Lauridsen and Jørgensen (2010) to be a window of opportunity.

6.2.5. DISCUSSION OF OPPORTUNITIES FOR INCORPORATING PREPARATION FOR REUSE

The current WEEE management system in Denmark is on a trajectory towards recycling. This is due to technological, institutional and organizational conditions. In the following, scenarios are presented for unlocking the current system.

6.2.5.1 Modification of elements in a maintained system

The current WEEE system is designed for treating the waste/emissions, and can thus be described as an end-of-pipe approach where there is no focus on creating additional value from the collected waste. It is important to note that different waste management solutions can coexist, and the inclusion of PfR and reuse does not exclude recycling. If PfR were integrated into the current WEEE management system, the overall system architecture would remain unchanged, while selected components or processes could be modified. The majority of the WEEE cannot be reused (Parajuly & Wenzel 2017, WRAP 2011) and should thus continue to follow the current WEEE flows. Despite still being an end-of-pipe solution, the increased reuse would have upstream consequences for the overall production and consumption patterns. Increased reuse would result in decreased production and waste.

Today, billions of products are in use in households. These products will become waste and will need treatment. For this reason, we subsequently develop our suggestions for a modification of selected elements in the system, involving maintenance of the overall system but with the incorporation of PfR processes.

Prerequisites for preparation for reuse and windows of opportunity

Based on the identified constraints, we can point towards prerequisites that need to be in place for PfR to become an integrated part of the WEEE management system.

The first prerequisite relates to the technological constraints of investments in recycling facilities. The recyclers' concerns about getting sufficient amounts of WEEE to be able to gain return on these investments are not just linked to PfR, but also to the issue of short tender contracts. Longer tendering periods could provide recyclers with some certainty about their future license to operate. This would have another effect, i.e. willingness to invest in technologies for improved recycling. In terms of the delayed flows of WEEE, this would only be an issue in the transition period until flows had stabilized in the new system.

The second prerequisite is to improve the collection system to preserve the reuse potential of the WEEE. The municipal waste authorities are responsible for this part of the system. Thus, incentivizing the municipalities is key to value-conserving logistics. This could imply a fair distribution of costs and benefits among actors involved in the management of WEEE. Similarly, if the municipal waste authorities were actively involved in organizing and conducting PfR, they would have an incentive to preserve the reuse value.

A third prerequisite would be that PfR must be performed by qualified workers following certain standards such as the PAS 141, the Flemish Code of Conduct or the methodology developed by Bovea et al. (2016). This is to ensure environmental

benefits (only reusing the WEEE that entails additional environmental benefits), the quality and safety of the prepared products, consumer rights and guarantees, and monitoring and data registering.

A fourth prerequisite regards measures to ensure that the prepared products stay in Denmark, preferably being sold locally in order to re-enter the already established recycling system once they are discarded for good (to avoid transboundary e-waste trade).

Finally, the legal aspects that result in uncertainty must be clarified. A clear political vision is needed in order to decide how PfR should be organized, including who should have access and which requirements and standards should be pursued. The political vision for PfR depends on the objectives of PfR: should it mainly be included for environmental, economic or social reasons? The objectives determine which measures will be taken in the future.

The targets of the WEEE Directive have been set to meet the environmental problem, not to create business opportunities. However, as markets change, some waste materials have become competitive in market terms and have given rise to private businesses. In the same way, a national political vision for WEEE can be steered by environmental, social and/or economic objectives. If the underlying objective for performing PfR is to reduce environmental impacts, it may be of less importance if the business is profitable. Today, much waste is handled by public authorities, because private actors cannot handle it profitably. On the other hand, if PfR is only to be pursued in order to support an economic agenda, other types of initiatives will have to be launched. Finally, the social potentials of reuse are the most evident (Curran & Williams 2010). The nature of a future model for PfR depends on the overall aim and visions of the WEEE system. Is the aim mainly:

- to extract and conserve the material resources in the waste?
- to protect the environment and human health from negative impacts?
- to create business and economic value?
- or to ensure jobs, social equity and human prosperity?

A pilot testing of different models for the PfR of WEEE could provide experience and insights into how different solutions could work. Such a niche testing could be scaled up to regime level, if the experiences turned out to be good. Evidence from the niche markets that do exist suggests an increased potential. The niche markets are different, though, and only the non-profit reuse shops report on successful sales of second-hand consumer EEE. Since no serious attempts have been made to develop a viable business in the PfR of household WEEE, it is at this stage largely impossible to conclude whether or not this has economic business potential.

6.2.6. CONCLUSION

Preparing products for reuse has the potential to produce environmental, social and economic benefits, but currently not much preparation for the reuse of used electrical and electronic equipment occurs in Denmark. The targets of the WEEE Directive are solely met through recycling. The analysis highlights that there are technological, institutional and organizational constraints for Pfr as well as conflicting interests, which hinders WEEE being prepared for reuse.

- The technological constraints reside in the investments in facilities for WEEE recycling. Private actors (the recyclers) are economically bound to these investments, and thus have a strong incentive to preserve the current system.
- The organizational constraints resides in the practices that have developed around the recycling technology. The one-sided focus on recycling gives no incentive to handle WEEE carefully, and consequently the reuse potential of the WEEE (functionality and appearance) is destroyed. Protecting the reuse potential will be more costly, and there are disagreements over who should pay for this.
- The institutional constraints stems from vague formulations in the Danish transposition of the WEEE Directive. There are uncertainties among the actors regarding rights and ownership of the WEEE, and consumer rights. Moreover, the sales of reused products may conflict with sales of new products and with the general political focus on economic growth.

There is disagreement about who should have the right to perform Pfr. None of the actor groups involved seem to perceive Pfr as a particularly good business opportunity from a purely economic perspective. However, the actors who already run second-hand shops at local level would like to get access to the WEEE in order to prepare it for reuse. These second-hand shops are non-profit organizations and largely driven for social or environmental reasons, not just economic. A market already exists for the direct reuse of electronic products (consumer to consumer) and this indicates that there is a potential market for the reuse of WEEE.

The present conditions also create a window of opportunity for modifying the system, the most important being a positive public attitude towards reuse, pressure from EU legislation and growing niche markets. However, external intervention is needed, i.e. from policymakers. A future model for Pfr depends on the overall aim and visions of the WEEE system. Are they to extract and conserve the material resources in the waste, to protect the environment and human health from negative

impacts, to create business and economic value or to ensure social equity and human prosperity?

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6.3. DEVELOPING A BUSINESS MODEL FOR PREPARATION OF WEEE FOR REUSE IN AVV

The second part of this sub-study describes and analyses the process of developing preparation for reuse (equal to refurbishment) of WEEE activities in AVV. As described in Article B, the current socio-technical system for managing WEEE promotes recycling and inhibits reuse, and there are no signs that the regime of WEEE management are going to incorporate solutions that enable reuse. Consequently, the waste hierarchy principle of the circular economy is not endeavored and supported by the system. Changes in systems (or regimes such as the WEEE management system) can begin with developments at niche level (Schot & Geels, 2008). Schot and Geels (2008: 538) argue for the need of facilitating sustainable innovation journeys *“in protected spaces that allow nurturing and experimentation with the co-evolution of technology, user practices, and regulatory structures”*. The aim of such experiments is to directly address knowledge gaps, learn about performance, effects, economic viability and social desirability of a new solution (Nill & Kemp, 2009). These learnings can provide important information for policies for the further development. Central to strategic niche management is that learning is the explicit goal (ibid). In order to strategically use such niche experiments to gain learnings for future policies, policy support for the niche experiments is needed in order to provide protection for the experiments and to safeguard investments (Nill & Kemp, 2009).

The following is a case study narrative building on field notes, participatory observations and ethnographic interviews about AVVs journey to setup up a niche experiment to bring about learnings about the barriers and possibilities for creating a circular business model for refurbishing WEEE. The analysis aims at understanding and assessing how and under which circumstances niche experiments with WEEE refurbishment can provide sufficient learnings to contribute to changes in the regime of WEEE management.

6.3.1. CASE STUDY NARRATIVE: THE PROCESS OF DEVELOPING PREPARE FOR REUSE IN AVV

Reuse and refurbishment of WEEE was a common theme of interest already in the initial meetings between AVV (Innovation manager and CEO), my supervisor at Aalborg University and I. Due to the particularly problematic features of WEEE (described in the article), we quickly agreed upon WEEE to be one of the core themes of the PhD project. In the following, I will make a chronological account of the process of developing prepare for reuse of WEEE in AVV in order to increase the understanding of what considerations, motivations, difficulties, risks etc. that AVV has encountered in the process. Inspired by Van de Ven et al. (1999), I will begin by describing the gestating elements in AVVs history in order to show what

background, values and motivations AVV has for engaging in activities for improvement of the WEEE management system.

6.3.1.1 WEEE in AVV prior to the implementation of the WEEE Directive in 2003

Today, AVV equips an area at each recycling center with cages for collection of WEEE. Different cages are set up for the WEEE fractions shown in table 6.4, and AVV collected 1554.214 tons of WEEE in 2016.

When full, the cages are reloaded and transported to treatment facilities. This transport is organized by the collective scheme that has won the tendering contract. The collective schemes that operate in AVV was in 2015-2016 Elretur and ERP. A new tender period came into force in 2017, making Recipo the responsible scheme.

Table 5.4 Tons of WEEE collected at AVVs recycling centers in 2016

WEEE type	Amount (ton)
Electrical and electronic equipment	523.338
Televisions and monitors	235.446
Large household appliances	795.430
Total	1554.214

The implementation of the WEEE Directive implied a significant reduction of AVVs area of responsibilities. Prior to the implementation of the WEEE Directive, AVVs management of WEEE was much more comprehensive than it is today. The following narrative is based on an interview with the innovation manager. Around 1990, increasing amounts of electrical and electronic waste appeared at AVVs recycling centers due to increasing amounts put on the market. This WEEE mainly comprised cathode ray TVs, radios and household appliances, and it was discarded in the containers for combustible, landfill and iron and metals for recycling. At that time, there were no legal requirements to municipal waste authorities regarding the management of WEEE, but AVV decided to do something about it. Together with three other Danish municipal waste authorities, they experimented with organizing separate collection of WEEE. The four municipal waste authorities divided some tasks among each other: AVV was to manually separate TVs in order to identify what TVs were comprised of and how these materials could be treated best from an environmental and resource conserving perspective. They proactively investigated how and who could treat each waste material contained in a TV for recycling. They

made a dismantling manual for TVs for the other municipal waste authorities, whereas the others made dismantling manuals for refrigerators, coffee machines and radios. *“We were idealists then. Our main reason for doing it was that we thought that too many values and resources were lost. Additionally, we wanted to eliminate the environmentally harmful emissions that resulted from the burning of it. So we started separating it”* (innovation manager). Soon nine people were employed in the manual disassembly of WEEE, and AVV invested 70,000 Euros in a machine that could assist the separation of the interior of TVs into two different types of glass and metals for recycling. Moreover, they removed mercury-containing switches from coffee machines and freezers, not with the aim of recycling, but to dispose it in German mines (landfill) in order to hinder the further use and spread of it. The innovation manager is proud of their choice to dispose of mercury in mines rather than recycle it in order to gain the highest environmental benefits. He is not convinced that the implementation of the WEEE Directive entailed improvements concerning the environmental impacts of WEEE: *“Now we wonder what happens to the mercury in present facilities where appliances are shredded”*. In addition to his doubts about the environmental benefits of the current WEEE system, he says: *“We were sorry in 2003, when we had to cut 9 jobs”*. Even though, the implementation of the WEEE Directive reduced the costs for managing WEEE for AVV, the loss of jobs were considered a setback in AVV.

6.3.1.2 Current sales of post-consumer EEE in the reuse shop

Today, AVV sells some post-consumer WEEE in the reuse shop. This is mostly small household appliances, like coffee machines, boilers, irons, hair dryers, tools, lamps, little ovens, micro ovens and the like. They are sold at prices ranging from 30 DKK to 200 DKK.

Not many citizens donate large household appliance for reuse, but when a large household appliance is set for sale in the reuse shop, it is easily sold, and the reuse shop personnel experience that there is a larger demand for large household appliances that can be met by the current supply.

In 2016, the sales of post-consumer WEEE (technically used EEE, as consumers have donated it and not discarded it as waste) in AVVs reuse shop is accounted for in three product groups, denoted lamps, large household appliances and electronics. Table 6.5 shows each product groups contribution to the annual income in the reuse shop and how large a share of the total income they each account for.

Table 6.5 Income from used EEE products sold in AVVs reuse shop.

Product type	Income excl. VAT (DKK)	% of total turnover
Lamps	116,702	2 %
Large household appliances	8,028	< 0 %
Electronics	287,528	6 %

The table shows, that there is a market for post-consumer WEEE, but that this product group only accounts for a small part of the sales in the reuse shop.

6.3.1.3 Initial inspiration from the circular economy concept

In December 2013, when I started the PhD project, we were inspired by the Ellen MacArthur Foundation's report on circular economy. One of the core messages in this report was that OEMs should take back their products after use in order for them to become nutrients for the production of new products. More specifically, this could be enabled through refurbishment or remanufacturing. From this backdrop, we started discussing how AVV could support such product take-back. Being the main point of drop of for consumers' used products, AVV (as well as every other municipal waste collection site) plays an important part of the collection infrastructure, but what the Ellen MacArthur Foundation suggested was in fact to disrupt this infrastructure and replace it with new types of takeback with OEMs holding the responsibility for this. This was in fact also the basic intention with the WEEE Directive. For AVV, whose greatest responsibility is to ensure collection of waste from households, this Ellen MacArthur Foundation suggestion at first sight would imply that they should no longer play the role as waste collector. In other words, AVV would be left out of the equation in a full implementation of the circular economy ideas. Given the fact that citizens have been "raised" to discard and separate their waste into a variety of fractions at the recycling centers in Denmark, the employees in AVV opposed to the idea of disrupting this, from their point of view, well-functioning waste collection system. We also discussed if it is realistic to imagine consumers bringing back every item they have ever bought to the place of acquisition, conducting a kind of reverse consumption. Due to the lack of practical examples of such product take-back, there were also doubts that a sudden disruption of the waste collection infrastructure would happen in the near future. Nevertheless, we decided to make an attempt to implement the circular economy principles with an outset in the existing infrastructure, and that AVV could proactively support this.

6.3.1.4 Suggesting infrastructural collaboration with OEMs to organize takeback and support circular business models

Two main enablers of the circular economy are pointed out by Kirschherr et al. (2017): Business models and consumers (Kirschherr, Reike, & Hekkert, 2017). How the consumers act and how they discard their waste determines the possibilities to prolong the life of products. It even determines, whether post-consumer products will be recycled for material recovery. For instance, one can easily imagine how difficult it would be to recycle a smartphone that has been discarded in the daily discard along with leftover foods etc. Citizens in Denmark have one place to discard their WEEE, and that is at the recycling centers⁷. Much effort has been made to teach consumers to separate their waste correctly, and especially it has been difficult to make consumers correctly discard small WEEE at the recycling centers rather than in the daily discard. By now, discarding WEEE at the recycling centers has become a rather routinized behavior among many consumers, and this has increased the amounts of collected WEEE significantly (even though there is still room for improvement). Consequently, Denmark is one of the EU member states with the highest collection rates of WEEE. Correct separate collection is the first prerequisite for enabling reuse or recycling. For this reason, AVVs concern about disrupting the established collection system is legitimate. Teaching consumers new ways of delivering their waste products at different drop-off points would add new challenges of transitioning to a circular economy. These considerations gave rise to the idea among AVV innovation employees, that rather than pursuing a disruption of the waste collection system, the municipal waste authorities could utilize the already existing and efficient waste collection infrastructure and use it as an enabler of OEMs to develop circular business models.

Based on this, I started mapping local EEE producers. There are not many in northern Jutland, but there is one producer of kitchen hoods located close to AVV. In May 2014, we contacted this company, and invited their CEO to a visit where I and a fellow PhD student presented the concept of the circular economy. We presented them with the idea, that AVV could organize the collection of their post-consumer products. This would require a national collaboration among municipal waste collectors to ensure collection of all their products, but less could do it for an experiment. We know from literature that organizing the takeback of used products is one of the major obstacles for OEMs to embark upon circular economy business models (Incentive, 2015), so helping the OEMs with this challenging task could be a way for AVV to support the transition to a more circular economy. But the Kitchen hood producer rejected the idea. Two other producers, to whom we presented the idea, also rejected it. For this reason, we decided to abandon the idea of collaborating with OEMs on WEEE takeback.

⁷ In some municipalities, collection of WEEE at the recycling centers is supplemented with additional collection methods such as collection at households.

6.3.1.5 Inspiration from Flanders on preparation of WEEE for reuse

Simultaneously, I was engaged in a collaboration with PlanMiljø⁸ on a project investigating the potentials for introducing formal preparation for reuse of WEEE in Denmark (some of the results of this project is presented in Article C). What is not addressed in the article is, that I went on a study trip to Brussels (Flanders) and London to visit workshops in which preparation for reuse of WEEE was conducted as a formal part of the waste management system, and to interview the involved parties, i.e. officers from the environmental protection agency, the collective scheme operating in Flanders and the UK, the organizing body, and the people working in the workshops.

Particularly the visit in Flanders was inspiring, because here much WEEE was actually prepared for reuse. Throughout Flanders, there were 31 publicly supported reuse shops in which post-consumer products that had been collected as waste, was prepared for reuse in workshops and sold in reuse shops as second-hand products. More than 300 people were involved in the preparation of WEEE for reuse. Flanders is similar to Denmark in terms of population size (app. 6 million inhabitants), and this made the numbers easily comparable to Denmark. The Flemish system was organized differently from the Danish system though. In Flanders, the part of the waste management system that organized preparation for reuse, was not just governed by the environmental protection agency, but also by the social welfare agency (Larsen et al., 2015). This was because the preparation for reuse activities enabled the employment of people with a weak connection to the labor market, such as refugees, people with abuse problems, and other challenged people. The preparation for reuse activities were combined with training programs for providing these people with practical skills and language competences (for foreigners). This combination of social integrity aims and environmentally superior waste management aims had been a prerequisite for this system to function.

The officers in Flanders emphasized some other factors of importance to the success of the programme, which had run since the end of the 1990s. The first success factor was the collaboration with the WEEE collective scheme. There was only one collective scheme in Flanders, not multiple as in Denmark. The second success factor was a quality-ensuring scheme, which ensured a standardized testing and preparation procedure, and a labeling to communicate this to the consumers. The third success factor was the use of a common brand for all the publicly supported reuse shops, De Kringwinkel (Larsen et al., 2015). Later, Flanders and Wallonia have set separate targets for reuse of WEEE (Rreuse, 2017).

⁸ PlanMiljø is a consultancy who provides consultant services within the topic of sustainability to companies, organizations and public authorities.

When I came back to AVV, I told the management and the employees in the innovation department about De Kringwinkel in Flanders. They were excited to hear that a well-functioning preparation for reuse of WEEE existed somewhere else. The case of the Flemish De Kringwinkel became iconic to AVV. *“If they can do it, so can we”* seemed to become a common understanding in AVV. Today, De Kringwinkel in Flanders is still frequently mentioned as a laudable example to be pursued. The Flemish example sparked the vision of developing a similar prepare for reuse workshop of WEEE in AVV.

6.3.2. DEVELOPING A NICHE EXPERIMENT FOR PREPARATION FOR REUSE OF WEEE

A first prerequisite for successful niche experiments is the articulation of expectations and visions as these provide a direction to the learning process (Schot & Geels, 2008). A vision for the establishment of a preparation for reuse of WEEE workshop in AVV was formally described in the summer of 2014 in the form of a project application for a funding programme:

“AVV wishes to investigate the possibilities to conduct preparation for reuse of WEEE as a new waste prevention measure taken before material recycling. AVV wishes to develop and test procedures and methods for preparation for reuse, and develop a solution for this, which can be scaled up to become a standardized national waste management solution”. This includes:

- *“Development of a standardized method for a) separating WEEE with reuse potential, b) preparing this for reuse.*
- *Examine the reuse potential of the WEEE that is collected*
- *Define the work tasks, the time and resources needed (estimate number of jobs per ton of WEEE prepared for reuse)*
- *Develop a scalable business model for the solution including a market analysis*
- *Develop a solution for a collaboration with the collective schemes, among other by developing a system for data collection and registering to feed into the present DPA system”*

(AVV, 2014)

The project should mainly focus on large household appliances as the environmental benefits of reusing these seem to be higher than for other product groups (A. H. Larsen et al., 2015).

Setting up an experiment for refurbishing WEEE required investments in workshop facilities and skilled labor, and due to the large degrees of uncertainty about the feasibility of a business model for this, including uncertainties about the ability to

actually bring the refurbished products to the market, and thus capturing some value to outbalance the investments, AVV chose to apply for funding. The list below summarizes the initial barriers and uncertainties for AVV to set up a workshop experiment. Making the funding application implied making a thorough analysis and planning of work objectives, packages and budgets. My involvement in the project with PlanMiljø implied that we could proactively take into considerations how other stakeholders in the system could benefit or at least how to meet their requirements. This included among other thorough data collection, development of standardized procedures to ensure quality, safety and environmental benefits (as described in Article B). The application was thus a detailed project plan describing steps and phases of the initial investigations needed to develop a business model experiment.

Uncertainties covered:

- market demand
- the quality of the supply (quality of the post-consumer products collected at the recycling centers)
- resources needed to improve the collection methods and thus protect the reuse value
- resources needed for testing and refurbishing the products
 - o labor and skills
 - o time
 - o facilities and tools
- how to monitor and register refurbished products
 - o data to be integrated into the current producer responsibility scheme
- how to test energy consumption
- how to market products
- potential resistance or cooperation from retailers, producers or other actors?
- how to ensure no export of used products
- consumer rights to warranty periods and guarantees of second-hand products

Inspired by Flanders and to respond to the financial uncertainties, I contacted the municipality's job center, arranged a meeting with an officer (in May 2014), and presented her to the plan. The officer was excited about the idea. In her words, this kind of workshop was exactly what they were looking for in the job center. They were short of companies that would and could employ socially disadvantaged people who could not perform a regular job. For them to engage a collaboration, however, there should be a training program developed that would ensure that these challenged employees would acquire certain skills. We agreed that the job center could be responsible for this part. The positive dialogue with the municipality's job center limited the potential financial risk of setting up the experiment and the system.

However, the resistance from the collective schemes, and also the ambiguity in the regulation (described in Article C) posed a need for legitimization of the project. Hence, the application to one of the Environmental Protection Agency's funds programmes was not only to receive funding but also to acquire a formal seal of approval. The application was declined in the fall of 2014, and this set the WEEE workshop experiment ideas on hold for the next two years.

6.3.2.1 Second attempt

Luoma-aho & Vos (2010) point towards the need for organizations to increasingly monitor the *"issue arenas"* in which they engage. Identifying important stakeholders should be done by identifying the important issue arenas (ibid). This is because *"interactions with stakeholders is moving from organizational control towards "issue arenas", places of interaction where an issue is discussed by stakeholders and organizations..."* (Luoma-aho & Vos, 2010). The WEEE system can be considered such an issue arena, and because AVV considered developing refurbishment activities for WEEE, following this issue arena became pertinent. By attending events in this issue arena, AVV could in theory not only get insights into stakeholders and their interests, but also potentially affect the debate taking place there. I, as well as other AVV employees, attended conferences and meetings in the sector where the topic was discussed. There tended to be two wings: those who supported the initiation of prepare for reuse. This group included AVV and other municipal waste management companies but far from all, supported by the consultancy PlanMiljø, some university researchers, and some environmental NGOs, and those who opposed it. This group included the WEEE collective schemes, the recycling industry, and the Confederation of the Danish Industry who in particular opposed the preparation for reuse being conducted by municipal actors. The environmental protection agency seemed to drag out decisions regarding the legality of preparation for reuse of WEEE.

Throughout these years, preparation for reuse of WEEE was discussed vividly in the sector at various occasions. In the beginning, the industry strongly opposed reuse of WEEE as it was against the interests of their members, i.e. producers and importers of EEE. In 2014, they engaged in a voluntary agreement with the Danish Ministry of Environment that aimed at identifying *"market driven measures that increase resource efficiency in all loops throughout the entire lifecycle for WEEE/EEE. The measures must link lifecycle thinking around product design, material optimization, re-use, refurbishment and recycling for WEEE/EEE across the value chain, and at the same time ensure a good business environment for circular economy"* (The Danish Voluntary Agreement on WEEE, 2015). They thus aimed to develop their own solutions to how the eco-design, better sorting, reuse and recycling of WEEE could be promoted in a business context (Dansk Industri, 2014).

In February 2017, a conference was held by The Confederation of the Danish Industry presenting the preliminary results of the voluntary. Their main conclusions were

- The market can handle many of the challenges related to used electronics without public funding, and there is a large business potential in new circular solutions
- Regulations should ensure a removal of current barriers for circular business models, and encourage increased reuse
- Producers and importers should have unlimited access to the WEEE collected at the municipal recycling centers

(Dansk Industri, 2017)

Even though, the main conclusions presented did not differ much from the views that the industry had expressed earlier, it was my impression that at this conference, the atmosphere had changed. The discussions in the room were not as conflictual as they had been on previous conferences and meetings, and there were no signaling of opposing opinions with headshakes as we had also encountered previously. The two wings seemed to have somewhat dissolved, and there seemed to be a consensus that in order to transition to a circular economy, reuse was to be supported too. Some private companies (whom the Confederation of the Danish Industry represented) had made circular economy project investigating their own business potentials for leasing models and remanufacturing. The minister for environmental and agriculture held a small speech about the importance of circular economy. In general, the discussions of preparation for reuse/remanufacturing had moved from questions of “whether or not” towards a “how to”.

Moreover, I spoke with the manager of the one the largest collective schemes (I had talked to him on the phone a few days before too), and he showed interest in collaborating with on an experiment on WEEE refurbishment. He was surprised by AVVs commitment and our visions to develop a robust system that could be scaled up nationally, and even more surprised by our invitation to collaborate. So far, he had seen the municipal waste recycling centers and reuse shops as “*the wild west*”, where illegal activities and export by Eastern Europeans were widely conducted. A visit in AVV seemed to change his perception towards a more positive one and he agreed to engage a collaboration. Stakeholder interests are not so static after all (Luoma-aho & Vos, 2010).

In the spring 2017, AVV decided to make a new project description and send in a new application. This time with the support of the largest collective scheme Elretur and another collective scheme Recipo, under certain circumstances (that we ensured high quality, safety and environmental benefits, and ensured that the amount of refurbished products were monitored, registered and solely sold on the local

market/not exported). Their support provided an important legitimization of the project. The importance of engaging with legitimizing stakeholders is emphasized by (Mitchell, Agle, & Wood, 1997).

In addition to the newly established collaboration with Elretur and Recipo, a small one-man enterprise, De Grønne Hvidevarer, became an important collaborating stakeholder. He had experimented with refurbishing large household appliances. The owner was an electrician, who had the technical skills to refurbish appliances. Skills that were not present in AVV. Hence, with him on board the new project application, one more business model challenge (skills and competences for refurbishing WEEE and operating a workshop) was solved.

The last partner was the municipality's job center, with whom AVV had already initiated another workshop project (this is described in chapter 7).

This second project description thus differed from the first one by focusing on shared value among stakeholders and shared support, and it was similarly thoroughly described and planned as the first application. Unfortunately, this application was also rejected.

Despite thorough studies, detailed project descriptions, work and time plans, extensive networking and initiation of new types of collaborations, AVV has still not managed to setup the workshop experiment. Visions, strategies and plans do not necessarily entail implementation.

6.3.2.2 Analysis and discussion

The gestating phase, i.e. AVVs history of proactively investigating and developing environmentally better solutions for the management of WEEE, shows a sincere motivation and interest, which does not stem from imagined opportunities of economic profit, but from environmental concerns. The social benefits that the WEEE dismantling in the 1990's and early 2000's in the form of jobs was a positive side effect, but also became a performance criteria in addition to the environmental aims. Moreover, the narrative shows that AVV have always considered how to operate in the upper levels of the waste hierarchy and proactively pursued this without consciously formulating it in terms of either the waste hierarchy, the circular economy or triple bottom line.

When the industry confederation put more emphasis on the value of private actors and market based solutions, this arises from economic considerations and convictions that market based solutions will be more beneficial for society, in the form of job creation and environmental benefits. The motivation and line of reasoning are thus different. The end result may or may not be the same, but in this initial phase these two stakeholders (AVV and the Danish Confederation of

Industry) are split in two sets of identifications based on separate logics about how to transition to a circular economy.

AVVs logic may stem from a “waste management logic” rather than a “circular economy logic”, as the focus has never been on creating economic value, but to improve the management of the WEEE that is generated. Oppositely, the industry (representing private producers and importers) bases their logics on more on the circular economy ideas of maximum value extraction through design for refurbishment. This logic is based on an assumption that there are values to be extracted and business potentials in designing products and business models for circularity, as suggested by the concept of the circular economy, most notably by the Ellen MacArthur foundation and in a Danish context by Parajuly & Wenzel (2017). The two actors view the issue from different perspectives and neither of them has the full overview of the value chain and of consequences of circular activities launched in different parts of the value chain. The main conflict seems to be whether preparation for reuse of WEEE can be conducted by public organizations or whether the market alone can handle the challenge through development of circular business models for refurbishment. I will argue that this dichotomy is ill suited for developing more sustainable and circular solutions within the production and consumption system of the EEE product group. There is not consensus about the goal. This places the situation in square C of the planning model presented in chapter 2, and this expresses a need for bargaining and negotiating towards an agreement about the goals or development of means to reach several goals simultaneously.

The WEEE Directive is an example of a regulation that builds on the “circular economy logic”, but which is implemented into a waste management logic. The Directive aims at supporting a circular economy including the principles of producer responsibility and takeback. In principle, municipal waste management authorities should play an insignificant role, while producers would aim to extract the maximum value and thus manage the circulation of the EEE products and their materials. In practice so far, the circular economy potentials does not seem to have been so obvious to producers and importers that a larger shift in the regime has happened. The top-down approach to changes in the regime has not entailed the expected results. The uncertainties seem to hinder the implementation of inner-loop practices and business models for longevity, reuse and refurbishment.

To deal with such complexity, strategic niche management have been suggested as protected spaces in which trial-and-error modes of learning can be facilitated (Nill & Kemp, 2009; Schot & Geels, 2008). In a practical experiment as a workshop setup, learnings can be gained to dissolve some of the complexities and uncertainties that currently seem to hinder the wide spread diffusion of solutions for returning post-consumer WEEE into the market and into a second cycle of use. These learnings concern

- How collection can be organized to protect the reuse potential
- How information about the post-consumer products and their condition can be acquired
- How much of the collected WEEE can successfully be prepared for reuse and sold for reuse
 - o With what type and amount of investments
 - o With what labor input (time, types of job, required skills)
- How quality, safety and environmental benefits can be ensured
- How illegal exports can be hindered
- How registering can be developed to fit into the Producer responsibility system
- What the environmental benefits are
- How many jobs of which types can be created where
- And finally, if and how it is possible to run a viable business on this or not

Estimates have been given on several of these aspects, for instance by Parajuly & Wenzel (2017), but practical demonstration may be necessary to reduce the uncertainties further and clarify the potentials, benefits and investments needed. Moreover, learnings from experiments do not just encompass this type of first-order learning (generation of facts and data), but by involving a broad range of stakeholder from different life cycle phases, experiments can facilitate second-order learnings, such as changes in cognitive frames and assumptions, generation of a deeper understanding and new perspectives and ideas, which may not be imagined at present moment. In this regard, Schot & Geels (2008) emphasize the importance of working in networks that contain a broad range of regime actors. On a similar note, *Successful circular projects are based on innovative collaboration models*” (Kraaijenhagen, van Oppen, & Bocken, 2016). Such could be developed through niche experiments, in which networking, negotiations about means and ends could be facilitated. Yet even if experiments gather a range of stakeholders, there is no guarantee for second-order learning. To support this kind of learning, niche experiments should focus on concepts, visions and guiding principles rather than technologies (Schot & Geels, 2008). There seem to be some consensus about the guiding principles and visions among the stakeholder groups, i.e. that there is a need to transition to a circular economy. Building on this consensus, experimentation and bargaining can take its outset. AVVs workshop experiment may in its project descriptions have put too much emphasis on the first-order learning, i.e. clarifying the above described uncertainties, and thus left too little room for visioning and to how to proactively influence regime actors and cognitive frames, such as bridging the gap between the two dominant logics of the industry and the waste management. However, the most recent negotiations with the collective schemes is step in this collaborative direction.

This analysis supports the idea that a future system for refurbishment of WEEE, whether as a prepare for reuse waste management solution or as a circular business

model on refurbishment, could be developed through a protected niche experiment. In order to establish such a protected niche experiment AVV might have to increasingly 1) acknowledge that the aim is *learning*, not creation of jobs or innovative development of the business. Learning, elimination of uncertainties, bargaining, development of new ideas and visions is an aim that all actors in the regime of WEEE management can agree upon, because all regime actors seem to have accepted the need for increased circularity. They have, in other words, all acknowledged the sense of urgency, which Schot & Geels (2008) also point towards as success factor for niche experiments. 2) AVV might have to be willing to move the WEEE workshop out of the operations of their own waste management. At present moment, AVVs motivations for engaging in a WEEE workshop experiment may stem more from a company vision to transition by developing new circular business solutions than to develop new circular systemic solutions.

That being said, there are good arguments for establishing a niche experiment close to a recycling center, since post-consumer WEEE is collected here. WEEE is one of the fastest growing waste streams, and AVV collected 1554.214 tons in 2016. Even though circular economy is high on the agenda and businesses are encouraged to rethink their business models, there is good reason to believe that AVV will continue to receive many tons of WEEE in the future. This makes circular solutions for post-consumer WEEE important, and niche experiments can enable the development of such solutions that can be scaled up at regime level.

CHAPTER 7. POTENTIALS FOR VALUE CREATION FROM WASTE IN AVV

One of the principles in the circular economy, which distinguishes from traditional waste management, is the aim of value creation. As expressed by Webster (2015), the aim is to extract maximum value out of products throughout their lifecycle. This chapter explores the value creation potential of the waste collected in AVV through two different perspectives. The first section consists of a scientific article, which is partly based on a study of one of AVVs projects. This project aimed to maximize the collection of waste for reuse and recycling through different activities at one of the recycling centers. The data from this project formed the basis of assessing the potentials for increased value capture from increased collection of recyclable and reusable waste. This study additionally provides some important considerations regarding what value is and to whom.

The second part of the chapter is, like the second part of the previous chapters, a look inward in AVV on the processes of developing new solutions from the outset of the circular economy concept. In this section, I describe the innovation journey that preceded the establishment of GodtGjort (BM6) in order to identify the enabling conditions in AVV, the challenges and success factors of moving from waste management to circular business models, and finally a discussion of whether this is actually beneficial and to whom.

7.1. ARTICLE C

Title: “Local value capture from increased collection for reuse and recycling”

Authors: Kristina Overgaard Zacho, Mette Alberg Mosgaard, Henrik Riisgaard

Status: Accepted for revision process in the journal “Resources, Conservation and Recycling”

Abstract

The current call for a transition towards a circular economy is often accompanied by an assumption that there are value creation potentials to be captured along with increased resource efficiency. In this study, we aim to provide more detailed knowledge about the size and characteristics of the potential value to be captured from the resources embedded in waste. In order to investigate circular economy potentials in a real-life context we apply case study research. The case is a municipal waste management company collecting and managing household waste. A number of initiatives are employed to collect as much waste for reuse and recycling as possible. The waste fractions with the highest collection potential are identified as being cardboard, plastics, waste wood and items for reuse. The subsequent processes of preparing these waste types for reuse and recycling are analyzed through the lens of circular economy value creation. The data include waste amounts, the company’s economic accounting, interviews and observations. From the perspective of the municipal waste authority, the largest value creation potential (economically, socially and environmentally) lies in preparing waste for reuse. Secondly, cardboard for recycling has an economic value potential. Collection, preparation and sales of waste wood and plastics constitute an economic deficit and hold limited environmental and social value. The findings suggest that current regulation of the waste sector does not sufficiently support a transition to a circular economy. From a focus on cost-effectiveness, waste managers must additionally change their mindset towards a focus on value creation.

Key words: circular economy, waste, waste management, value creation, sustainability

7.1.1. INTRODUCTION

The circular economy (CE) highlights the need for a waste management that aims to recover the resources in waste. As the concept of the circular economy has come to play a guiding role in contemporary EU waste legislation (European Commission, 2017b), EU member states are required to collect and prepare 50% of household waste for reuse and recycling by 2020 (EU, 2008). However, the circular economy is often conceptualized as more than a material resource-recovering strategy. Most conceptualizations of the circular economy additionally place emphasis on value creation. For instance, value creation seems to be the guiding principle for the circular economy in the definition of Webster (2015):

“a circular economy is one that is restorative by design, and which aims to keep products, components and materials at their highest utility and value, at all times” (Webster, 2015).

For waste managers this implies a shift from a focus on cost-effectiveness in waste collection and management to a focus on creating value from waste (Stahel, 2016). One of the core principles of the circular economy concept is that the largest value creation potentials assumedly exist in extending the lives of products and their components (Macarthur, 2013). This can be done through different measures such as maintenance, repair, refurbishment and remanufacturing. These measures correspond to “prepare for reuse”, which is one of the top priorities in European waste management (EU, 2008). The circular economy ranks different resources strategies in the same order as the waste hierarchy, following this order of priority:

1. Prevention
2. (Preparation for) reuse
3. Recycling
4. Energy recovery
5. Disposal

(EU, 2008)

Thus, the circular economy and the EU regulatory frameworks for waste management apply the same basic priority principles for waste management.

Denmark is assessed as having the potential for improved utilization of the resources in waste, because more than half the country’s waste from households is currently incinerated (Danmarks statistik, 2015). The country has a well-established waste collection system with one point of pickup for citizens’ waste, and sound data on the collection of household waste and its treatment. Landfilling with household waste amounts to 1.7%, and 44.7% is collected for recycling (Danmarks statistik, 2015). How much waste, if any, is prepared for reuse is not accounted for in the statistics.

This means that most of the waste materials currently “returned to the loop” from the established waste management system are recovered as materials or energy, not in their original product or component form. Following the circular economy principles, there should be the potential for waste managers to extract more value by collecting more materials for recycling (rather than incineration) and more products for preparation for reuse.

Household waste is a challenging and costly type of waste to collect and manage due to its heterogeneous character (Hoornweg & Bhada, 2012). Hence, in Denmark, as in many other countries, the management of household waste is a public task financed by citizen fees and organized by the municipality. This study deals with this first part of the waste management system, i.e. the municipal waste authority that collects and prepares waste for reuse, recycling, incineration and disposal. Municipal waste authorities hold an important key for transforming the waste regime into a more circular and sustainable one, as they are involved in developing the infrastructure that facilitates recycling. In recent decades, there has been a move towards increased recycling, but recycling solutions have not yet been deemed so economically sound that disposal and incineration have been completely eliminated. Rather it is the government-imposed taxation on incineration and disposal that has driven the development towards increased recycling. The movement up the waste hierarchy has thus been more a push away from disposal and incineration than a pull towards recycling (Gregson, Crang, Fuller, & Holmes, 2015). Currently, the 2020 targets for collection and preparation for reuse and recycling are pushing the municipal waste authorities in Denmark to develop new solutions to replace the thus far predominant incineration (Miljøstyrelsen, 2014). Municipal waste authorities have a monopoly on household waste, and thus they have the legal obligation to ensure that these EU recycling targets are met.

Municipal waste management operates on non-profit terms. This implies that the citizens’ fees are continuously adjusted on the basis of the economic performance of the waste management. Consequently, cost-effective management should be pursued in order to keep the fees at a minimum. This logic regarding waste management is different from the circular economy logic. A circular economy aims to extract the highest utility or value of products, components and materials at all stages of the value chain (Stahel & Stahel, 2016; Webster, 2015), including the end-of-life stage. What is thus of interest to the present study is how a municipal waste management company can make this shift in logic towards a more explicit focus on extracting value from waste.

The aim of this research study is to develop a better understanding of the value creation potentials of increased collection and preparation of waste for reuse and recycling in a municipal waste management company in Denmark.

The study presents a practical example of what the potentials are for capturing value from increased collection for reuse and recycling within the established waste management system. The purpose is to investigate how the circular economy concept applies at a practical level from the perspective of the municipal waste management. We analyze whether and how the value creation potentials emphasized in circular economy literature are also valid for a municipal waste company, and discuss whether the benefits of an improved collection of waste products and materials are commensurate with the additional efforts and expenses needed to enable it.

7.1.2. VALUE IN WASTE

As we aim to explore value capture potentials from increased reuse and recycling, the concept of value is central to this study. Geissdoerfer, Savaget, Bocken, and Jan (2017) found that most conceptualizations of the circular economy place emphasis on the economic value potentials and job creation potentials.

Whether and how waste materials/products are recirculated is often determined by their economic value. Value, however, is not a constant. It is often the perceived value or valorization potential that determines whether a material/product is considered waste or not (Barr et al., 2013). The user discards a product once (s)he no longer appreciates it. Yet, for another person the value of this product could be high. The dynamic character of the value of a product during its lifetime is illustrated in Figure 7.1. By the time a product is discarded as waste at the local recycling center, the value of the product is at its lowest. The mix of materials in the product is a hindrance to utilization of these materials. The challenge, or opportunity, for the waste management company is to extract as much value from the waste materials as possible. Products generally have a higher value than the materials of which they consist (Macarthur, 2013). Hence, bringing used products back into use ought to be the recovery route with the highest value creation potential.

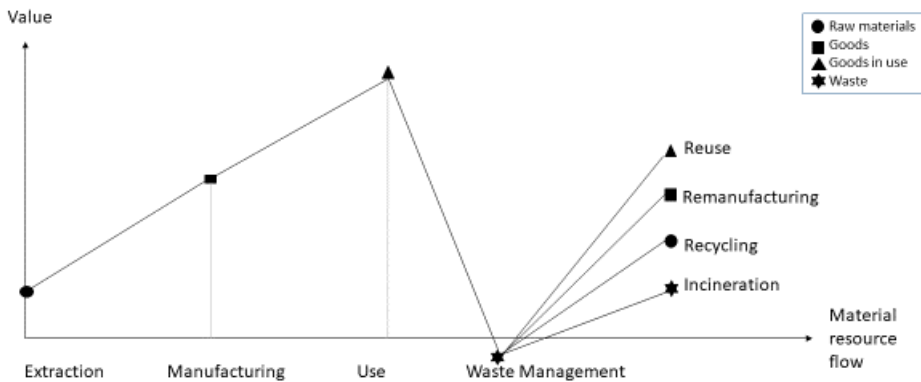


Figure 7.3 Value levels in the flow of materials. The choice of recovery routes made by the waste management company creates different potentials for extracting value (adapted from Ordóñez Pizarro, 2016).

Ideally, the materials and products travel from consumer to collector to secondary processor and back into consumer products (private as well as business consumers). However, there is a market in between every step in the chain (Zink & Geyer, 2017). The markets for secondary materials and products are often ignored in discussions on closing the loop of materials (Baeyens, Brems, & Dewil, 2010). This is problematic because the market forces to a great extent determine the fate of the materials and products. Secondary products and materials compete with new products and materials, and there is a sensitive relationship between supply and demand for materials. Any attempts to make business from the outset of a municipal waste collection would be restricted by the fact that the supply of materials (the collected waste) is fixed. The value creation process thus begins in the supply, not the demand. Contemporary business model innovation theories emphasize the importance of creating and delivering value to a market (the demand), and adjusting the supply to this (Chesbrough, 2010; Magretta, 2002; Teece, 2010). This challenge is core to understanding the value creation from waste. The market thus plays an important role in whether the loops will actually be closed in a way that displaces the use of new raw materials (Zink & Geyer, 2017).

More broadly, values also have to do with the relative importance, worth or usefulness that individuals or groups attach to things (Chan, Satterfield, & Goldstein, 2012). The term “value” is thus highly unspecific and covers more than just the monetary worth of something. From a sustainability point of view, values can, broadly speaking, be either economic, social or environmental, the latter often being a negative value in the form of environmental impacts. Tools exist for the assessment of these different value types, such as cost-benefit analysis, life cycle (sustainability) assessment tools, material flow analyses etc. Existing assessments of value generation from the recovery of waste tend to focus on one single domain of

value or merge different types of value into a monetary one (Iacovidou et al., 2017). We aim to take a non-reductionist view on value, i.e. we hold that it is not possible, nor desirable, to reduce all values to one single (monetary) value. From not being able to assess value using a common metric follows the challenge of how to compare different types of value. This issue of value incommensurability characterizes many sustainability-related decision-making processes (Pirgmaier, 2015). Despite the difficulty in making clear-cut value assessments, we find it relevant to explore how different types of values can be captured or lost when collection and preparation for reuse and recycling are increased at municipal level. In the study, we thus investigate the economic value capture as the sum of the costs from collection and preparing waste for reuse and recycling and the gains from the sales of waste materials and items for reuse. We assess the environmental value capture by applying and discussing previous life cycle assessments. Finally, we conceptualize the social value capture as job creation; the provision of opportunities for refugees, long-term unemployed and/or low-skilled, or otherwise socially excluded people, to get a meaningful job, receive training, build up practical skills, and get reattached to the labor market and to society; and the provision of opportunities for disadvantaged individuals to buy cheap second-hand products, thereby enabling them to maintain good living standards (inspired by Curran and Williams (2010) and Williams (2017)).

7.1.3. MATERIALS AND METHODS

The research is a case study conducted in a municipal solid waste (MSW) management company in Denmark. The MSW company operates 18 recycling stations where the citizens can bring their waste and sort it into up to 45 fractions for reuse, recycling, incineration or landfill. The company also organizes landfilling and operates an incineration plant converting waste into district heating and electricity. They additionally run a reuse shop on the premises. The company's main tasks are to collect household waste and prepare it for reuse, recycling, incineration and disposal. This means that the company operates at all stages of the waste hierarchy, except within actual material recovery and recycling, which is predominantly conducted downstream the value chain in the private sector. The company is a typical MSW management company and is thus a representative case for municipal waste authorities in Denmark. Not all municipalities operate incineration plants and reuse shops, however. This company is known in the waste sector for its reuse shop, which has existed for 30 years. Case studies are suitable for investigating phenomena within a real-life context (Yin, 2009). The circular economy assumption that value can be created and extracted from waste is a phenomenon worth investigating in a real-life context.

7.1.3.1 Scope

The focus in the rest of this article is on the household waste collected at the recycling stations, and we thus exclude the daily discard collected at households. This comprises nearly half the waste from the households in the municipalities in which the company operates.

A high percentage of waste is discarded in containers for combustible waste at the recycling stations. A study by Larsen, Petersen, and Christensen (2012) shows that 50% of the waste discarded in containers for combustible waste could have been sorted into other waste fractions. In this study, we test if this potential can be realized in practice.

7.1.3.2 Research design

The research design consists of four steps. In Table 7.1, the steps in the research design are supplemented with a short description of the sub questions that each step aims to investigate and by which method(s).

Table 7.6 The research design consists of four steps. Each step is aimed at answering a sub question by applying the most suitable method(s)

Research design			
Step	Aim	Sub questions	Method
1	To identify potential for improving collection	By reducing the amount of combustible waste, which reusable/recyclable fractions will increase?	Experiment at recycling station running for 6 months
2	To analyse tonnage diverted from incineration	How much can the collection of reusable/recyclable waste fractions be increased? What are their importance in terms of tonnage diverted from incineration?	Analysing weighing data from the experiment
3	To describe the further fate of waste materials	What happens with the waste after collection?	Qualitative study: - observations at the waste management

	and products	What input does the waste management company have in the preparation for reuse and recycling processes?	company - interviews with waste manager at AVV - interview with actors further down the supply chain
4	To find out how each of the identified waste materials contributes to value capture at the waste management company	From the local waste management's perspective, what are the economic, social and environmental value creating perspectives in increasing the collection and preparation for reuse and recycling of the identified waste types?	Analysis and discussion of the - economic activities associated with collection, preparation for reuse/recycling and sales of waste materials (company's accounting) - environmental benefits (previous LCAs) - social benefits in terms of job creation and addition to local prosperity (empirical data from employment in company)

The first step is an experiment conducted at the largest of the recycling centers in company. The experiment was designed with the aim of enhancing and improving the citizens' sorting at the recycling center. The purpose was to test the potential for diverting waste from the combustible fraction into other fractions for reuse and recycling. We focused in particular on the waste types that have previously been shown to comprise a significant part of the combustible fraction. These are paper, cardboard, plastics, wood, tires and reusable items (Econet, 2016; A. W. Larsen et al., 2012). These waste fractions are the ones that users tend to discard as combustible waste even though they should be collected separately for recycling. At the recycling center, there are separate containers for these waste types. More specifically, the experiment set-up comprised a number of activities previously suggested to improve the waste sorting at recycling centers. This included a reordering of containers to ease the access to the fractions that are recycled and reused, as suggested by Sundin et al. (2011), and a physical barrier established to make it slightly more difficult to access containers with combustibles. In addition, maps and information for the users were improved, and there were new signs for the containers. Color coding was implemented to indicate the fractions that were "green", but perhaps most importantly, more staff were employed to inform and guide the customers (Eklund, Kihlstedt, & Engkvist, 2010). The new staff that help the customers to sort the waste into the right fractions were chosen for their communicative skills and received special training to guide the users. The aim was not to assess the usefulness of the various activities, but to achieve an improved

sorting and a maximization of the separated waste materials by initiating a multitude of activities in the campaign at the recycling center.

During the experiment, we collected weighing data. The containers were weighed when they were transported out of the recycling center for further processing. Hence, we were able track changes in the amounts collected of all waste types as well as the amounts collected for incineration. We collected weighing data for 6 months (May–Nov. 2016) and compared the results with data for the same 6 months the previous year.

The second step comprised an analysis of the weighing data, leading to an identification of which waste types were predominantly sorted out from the combustible fraction.

The third step included an investigation of the further fate of these waste materials. The first management step after collection is the preparation for reuse and recycling within AVV. These preparation processes are qualitatively different for different waste materials, but common to them is the fact that this is the first step that increases the value of the products and materials. These processes, including how materials were managed, and to whom they were sold and why, were mapped and investigated through interviews, ongoing dialogue and email correspondence with the manager and two employees of the company. Economic data from the company on the sales of waste materials and on the expenses for collection and preparation for reuse and recycling were used to roughly calculate the monetary value capture from the different activities. Company representatives provided insights into the employee situation in the company, such as number and types of employees.

The fourth and last step consisted of an analysis of how the different preparation for reuse and recycling activities performed in the waste management company contributed to capturing value for the local society and for the local waste management company.

Based on this, we discuss our findings and propose future trajectories for how municipal waste management companies can apply circular economy thinking in their waste management.

7.1.4. RESULTS AND ANALYSIS

7.1.4.1 Tonnage diverted from incineration to reuse and recycling

The experiment at the recycling center showed that the combustible waste could be significantly reduced through targeted initiatives. The combustible waste collected at this recycling center accounted for 19.07% in 2015, but after the project initiatives

had been implemented, the amounts of combustible waste were reduced to 13.60% of the total bulky waste in 2016.

The next step in our analysis was to scrutinize the inventory in order to determine to which other waste fractions the “missing” waste in the combustible fraction had been diverted. Changes occurred in all waste fractions, but four fractions changed significantly, i.e. by more than 50%. Table 7.2 shows the percentage distribution of these four waste types in 2015 and in 2016. The end column shows the percentage change of the amounts collected in the two years. The waste types are listed in accordance with the size of the relative change; the waste type that changed its share the most is listed first.

Table 7.7 Percentage distribution in 2015 and 2016 of the four waste types that increased the most during the project due to a better sorting of the combustible waste. The last column shows the percentage change. In total, these four waste types account for 295 tons of waste diverted from incineration

	Percentage share of total waste collected		Change in %
	2015	2016	
Items for reuse	1.67	3.23	94
Cardboard	0.79	1.33	68
Plastics	0.50	0.83	66
Wood	5.25	8.06	53

The waste types that were predominantly sorted out from the combustible waste were

- *items for reuse,*
- *plastics,*
- *cardboard,*
- *wood.*

These waste types constitute more than two-thirds of the reduction in the combustible waste. The remaining third is other waste types such as iron and other metals, pressure-treated wood, paper, tyres and gypsum. These waste types also increased but not as significantly as the four listed above. Thus, we cannot ascribe with certainty the increase in the collection of these waste types to the project initiatives. Hence, the further analysis only includes the four waste types that changed the most.

7.1.4.2 Value of the diverted waste materials

In the analysis above, we identified which waste materials could predominantly be sorted out from the combustible waste. In this section, we will zoom out from the experiment and analyse the value and sustainability perspectives of these waste materials as they were in AVV in 2016.

The preparation process and its value

The waste materials and products are collected at the recycling stations, but prior to the collection, citizens spend time sorting their waste. The sorting done by citizens is a prerequisite for the system to function, and their sorting actions can be regarded as the first value-adding input in the recovery process. The value added by the citizens is largely unrecognized (Lane, 2014).

After the collection at the recycling stations, the waste materials and products enter different trajectories towards the same goal: recovery and re-entrance into the market (or in circular economy terms: closing the loop). In the following, we will go into more detail about the processes leading up to the closing of the material loop and how these processes add value to the materials and enable value capture for the waste management company and other actors along the supply chain.

Items for reuse

The collection of *items for reuse* nearly doubled during the project. Moreover, comprising 3.23% of the total waste in 2016, reusable items account for a larger part of the total than waste types like *paper*, *cardboard*, *plastics* and *WEEE*, and the amount is nearly equal to the fraction of waste from *iron and metals*. *Items for reuse* include a large variety of things, such as books, clothes and textiles, jars, china and pottery, furniture, building materials and bikes.

After collection, the *items for reuse* go through a preparation process before they are ready to be sold in the reuse shop and re-enter the market. This preparation process comprises transport, sorting, inspection, testing, cleaning, storage, moving, price tagging and selling and management of the process. It is a labor-intensive process that takes place locally on the company's premises. The reuse shop, including a workshop where the preparation for reuse processes are conducted, employs nine contracted full-time employees and six employees on special conditions who might otherwise have been outside the labour market. These have been employed through a collaboration with the municipality's job centre, and a mentor is associated with them and their job training.

Reuse-related activities generate positive social value by providing the opportunity for disadvantaged people to buy used products and maintain good living standards (A. Curran & Williams, 2010). Sixty-six per cent of the customers in the reuse shop are outside the labour market (students, unemployed and retired people) (company's

own customer analysis). For this group of people the possibility of buying second-hand may be important for their living standards. Therefore the reuse shop adds to the well-being of the citizens and the local social prosperity.

The economic value of the items for reuse is 806 euros per ton, and the annual turnover in the reuse shop is approximately one million euros. However, the labor and logistical input to the process are so costly that the income only just covers the expenses. The alternative waste management solution would be incineration. Incineration costs 440 DKK per ton of waste. The reuse shop, including the preparation for reuse process, is thus an economically advantageous solution for the company and the local community in the sense that it enables a reduction in the citizens' fees.

The products are sold in the reuse shop, whereby the material loop is at first sight closed locally. However, the environmental benefits of reuse are difficult to assess. Displacement of new products is a prerequisite for reuse to provide environmental benefits (Zink & Geyer, 2017). The extent to which the used products compete with new products is uncertain and almost impossible to account for. The company made attempts to investigate this, and their customer analysis (building on a questionnaire survey among 250 randomly chosen customers) indicates that about 65% of the used products displace the acquisition of new items. Due to the uncertainties regarding the displacement rate it is difficult to assess the actual environmental benefits more specifically. Zink and Geyer (2017) suggest that there may be a rebound effect connected to reuse: the money saved is used for consuming more, whereby the environmental benefits may vanish. This was also suggested by Gregson, Crang, Laws, Fleetwood, and Holmes (2013).

Cardboard

In total, *cardboard* comprised 1.33% of the waste collected at the recycling center in 2016, and the amount diverted from incineration to recycling more than doubled during the project period.

The first preparation for recycling of cardboard takes places at the company. Here, the cardboard is moved to other premises (logistical input), and pressed into pallets in order to be easily packed and transported. This requires labor input, but there is also a technology input in the trucks and machinery for the pressing. The company has invested in the technical equipment for the process. The cost of preparing the cardboard is lower than the cost for preparing plastics, because cardboard is a denser material with a lower volume. The cost of the preparation process is 35 euros per ton.

After the preparation process, the cardboard is ready to enter the market for the first time. The company sells the cardboard to a large international recycling company for 94 DKK per ton. Therefore, cardboard collection and preparation is profitable for

the case company. From the recycling company the cardboard is sorted and sold to paper mills in Europe. From this point, the case company loses track of the cardboard. The final (secondary) cardboard products are dispersed onto a global market mainly for packaging of products.

In contrast to many other recyclables, secondary cardboard is fully integrated into the production of new cardboard. Paper mills can use the fibers four to six times (Baeyens et al., 2010). The production of paper and cardboard from waste paper and cardboard requires virgin fibers to be introduced into the process. The rate of utilization of paper and cardboard is high and displaces the production of new cardboard, but not on a 1:1 scale. It must therefore be assumed that recycled cardboard contributes to the reduction of virgin wood materials. Nevertheless, the environmental benefits of diverting cardboard from incineration to recycling are ambiguous. Recent LCAs have shown that in cases where the energy recovery from incineration is high (where flue gas condensation is implemented, as in our case company), there may be no environmental benefits from recycling cardboard compared to incineration even if the recycled cardboard replaces the production of new cardboard (Merrild, Larsen, & Christensen, 2012).

Plastics

Plastics collected at municipal recycling centers represent a diverse fraction consisting of plastic films, plastic packaging such as cans, and hard plastics like garden furniture and PVC. These plastic types are collected separately at the RC, and did not increase equally. Combined they increased by 66%.

The preparation for recycling of plastics comprises equipment for collection, transporting, sorting out impurities, pressing into pallets and storage. The preparation process does not require much labor input, the main expense being the investment in machinery and equipment. The price for preparation for recycling is 80 euros per ton.

The local waste manager sells the plastics to a market broker. The price for plastic depends on the plastic type. Hard plastics and cans are passed on to the next actor in the supply chain for 0 euros, whereas plastic films have a high value. Yet, the prices for plastic films fluctuate greatly: in 2016, the price of plastic film fluctuated between 157 and 306 euros per ton. For this reason it can be advantageous to store the plastics until the prices reach a level that provide increased revenues (Louis & Shih, 2007). In total, the expenses of the preparation process exceed the income and the savings from incineration. Thus, plastic collection and preparation for recycling is a loss-making business for the case company.

After selling the plastics, their fate is unknown to the local waste manager. Therefore, the company has no guarantee that the plastics are actually recycled, and that there are actual environmental benefits from the process. The fate of the plastics

is affected by the market forces (for instance, the case company stores it until the prices are right), and it must be assumed that each market actor strives for profit maximization rather than full circulation. Moreover, the quality of polymers decreases during recycling, the result being that secondary plastics do not compete directly with primary plastics and thus do not displace virgin plastic in the production of new things (Zink & Geyer, 2017). The local waste manager has no evidence of the environmental benefits and is unable to affect the outcome of the recycling process.

Wood

Wood comprises a much larger part of the waste collected than any of the other recyclable materials (8% in 2016). The process of preparing wood for recycling includes transport to one of the case company's storage facilities. Here the wood is crushed and stored temporarily until there are marketing opportunities. The input into this preparation process consists of space for storage, machinery for crushing and a minor labour input. This process is priced at 24 euros per ton. The market opportunities for waste wood are limited. More specifically, the supply of waste wood far exceeds the demand. When there is a demand, the company sells the waste wood to a chipboard producer in Denmark for 0 euros. When there is no demand, the wood is incinerated with energy recovery in the company's incineration plant. At the chipboard producer, the wood is chopped, cleansed for impurities and dried. During the process, the used wood is mixed with virgin wood and glue. The used wood comprises 75–80 % of the final product (according to an interview with a chipboard producer). After pressing and treatment with a surface material, the chipboard is ready for sale. This company is the only chipboard producer in Denmark and they mainly serve the Danish and European markets. With the recycling of wood, employment opportunities are maintained in Denmark, but not locally in our case company's area. The chipboard manufacturer is owned by German shareholders, which means that the profits eventually leave Denmark. For the local waste manager, there is no profitability from the sales of waste wood, only costs for the preparation. The savings for incineration are smaller than for other materials, because waste wood is considered a biofuel and the same taxes are thus not imposed as for other combustible waste.

The environmental effects of using waste wood for chipboard production must be assessed from a systemic perspective. While the chipboard producer uses the waste wood in their production, Danish heat-and-power plants are increasingly using virgin wood chips as fuel to replace the use of coal. The chipboard producer uses waste wood rather than virgin wood chips for financial reasons: the prices for virgin wood chips are much higher than for the waste wood (interview). The virgin wood chip prices have increased due to energy-related legislation promoting the use of biofuels over coal. Hence, it is much cheaper for the chipboard producer to use waste wood. Consequently, virgin wood is incinerated and waste wood is recycled. The appropriateness of policies on waste wood and biomass for energy is discussed

by Knauf (2015), who fundamentally questions the benefits of cascading waste wood.

7.1.4.3 Preparation for reuse and recycling

The economic profits from increased collection of recyclables and reusable items can only be harvested after a process of preparing the waste for reuse and recycling. The character and extent of these processes depend on the waste type, and this affects the economic profitability of the waste materials. The preparation process consists of different types of inputs: technology inputs, and service and logistical inputs (Lane, 2014). The technology inputs comprise research, machinery and investments therein. Service inputs are human resources, marketing and human labor. Finally, the inputs can be of a logistical character: all the waste materials will need to be transported between actors and locations. The potential economic value capture of the used products and materials collected at the municipal waste management company not only depends on the market value of the waste material but also on how comprehensive the processes of preparing the products for reuse/recycling are. As illustrated in Figure 7.2, each step of the preparation process aims to add economic value to the wastes as they are gradually transformed into raw material, goods and products. The figure illustrates how the waste recovery industry resembles the mining industry extracting materials and transforming them into low-value raw materials for the production of goods. The economic value is the lowest at the collection point, i.e. at the recycling center such as in our case company. If/when the preparation process amounts to a deficit, it is the citizens who are ultimately charged the expenses. Nevertheless, the preparation process provides local jobs, hence the figure also encompasses social types of value. At which geographic scale environmental impacts occur is beyond the scope of this study.

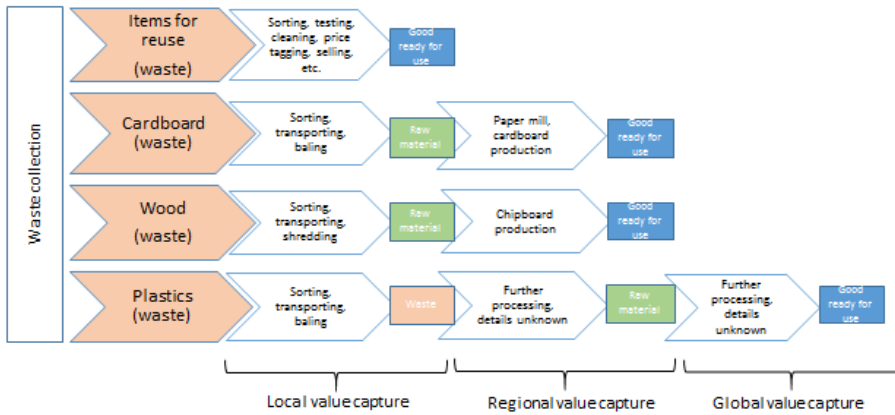


Figure 7.2 The economic and social value of collection and preparation for reuse and recycling increases with the inputs into the process. Value is captured on different spatial scales: the value from direct reuse is captured locally, whereas the value from recycling is captured in regional or global markets.

7.1.4.4 Summing up

Directing waste away from incineration towards reuse and recycling is not a profitable business for the municipal waste authority, except for cardboard. The products and materials collected for recycling induce economic savings due to the prevailing taxes on incineration and landfill, but apart from this, the value creation potentials are low from a purely economic point of view. Broadening the concept of value beyond monetary value nuances the value creation potential. Table 7.3 sums up the value capture from the four waste types.

Table 7.3 Sustainability perspectives for the five waste types. Local value creation from the collection and preparation differs greatly among the waste types

	<i>Items for reuse</i>	<i>Cardboard</i>	<i>Wood</i>	<i>Plastics</i>
Environmental	X	X	?	?
Social	1 job/100–300 t waste	1 job/1000–5000 t waste	1 job/1000–5000 t waste	1 job/1000–5000 t waste
Social	Job training for marginalized individuals Provision of second-hand products to disadvantaged groups of individuals = higher living standards	Regular jobs	Regular jobs	Regular jobs
Economic	Balances	Surplus	Deficit	Deficit

The used products (*items for reuse*) are the waste fraction, which provides the highest income to the municipal waste company due to the size of the fraction and its sales value. However, *items for reuse* do not have a value independent of the service and logistics put into the preparation for reuse. The process is so costly, mainly due to the labor input, that the income only just covers the expenses. The *items for reuse* could not be sold without this input. This means that the value of *items for reuse* at AVV does not reside in economic profits but in the local employment opportunities that it provides. Had the items not been sold for reuse, they might have been incinerated or used for landfill – solutions that are more expensive and also more environmentally harmful. From this perspective, it is actually cheaper for a municipal waste management authority to move up the waste hierarchy, i.e. prepare for reuse, than to recycle or incinerate it. Yet, the main value resides in the opportunities to create local employment alongside the assumed environmental benefits from reuse.

For the other recyclable materials (plastics, cardboard and wood) there are limited local employment opportunities. Together the collection and preparation of these waste materials employ approximately two additional people. The case company's

investments in machinery and logistical equipment for preparation can be financed by the income from cardboard. The collection and recycling of wood, which is the largest of the four fractions, does not provide either economic benefits or local employment opportunities. Moreover, the environmental benefits from wood recycling should be assessed as there seem to be inexpediciencies in the regulation for biomass for energy and for waste wood recycling.

In conclusion, direct reuse is the activity that adds the most to a municipal waste manager's sustainability performance and captures most value locally.

7.1.5. DISCUSSION AND CONCLUSION

The movement up the waste hierarchy has so far been driven by an environmental agenda relying on legislation and taxes on landfilling and incineration. These taxes ensure that material recovery is economically preferable for most types of waste (with a few exceptions). Our study shows that further efforts to increase the collection and preparation of recyclables provide limited or no additional economic benefit. For this reason, it cannot be expected that recycling levels will increase without further regulatory measures.

The study also shows that there is an unutilized potential for increasing the collection of items for reuse at the recycling center. It is fair to assume that a similar potential exists in other municipalities that do not yet provide separate collection for reuse. Municipal waste authorities are legally permitted to prepare waste for reuse and sell it in designated municipal reuse shops (Ankestyrelsen, 2017), but they are currently not obliged to prepare waste items for reuse, only to collect waste for recycling. Hence, there is no regulatory push towards increased reuse, even though reuse activities seem to hold the largest potential for value capture locally when taking a broad perspective on value. It could be argued, that it is beyond the authorization of a municipality to make business that may be competitive to similar types of businesses such as charity shops or even regular retail. The Confederation of Danish Industry has made this objection to municipally driven reuse shops (Ankestyrelsen, 2017). But municipal waste authorities already operate on market terms when they sell waste for recycling or for energy production. The only difference is that in these markets the value creation potential is much lower than in the reuse market. The extent to which there is a market for used products may have changed: there seems to be an increasing demand for second-hand products, which may not have been there just a decade ago. Municipal waste authorities can continuously adjust the supply of used products to meet the demand, and the leftover products can be directed to recycling or incineration. The preparation for reuse activities can thus more flexibly meet market demand than the recycling activities can.

Furthermore, waste companies that prepare products for reuse can add additional value to the products through upcycling activities, such as repairing a bike, washing the items before sale or making new clothes out of old textiles etc. In theory, only the imagination limits what value can be added to used products. In this regard, preparation for reuse also differs from preparation for recycling, which is limited to sorting, pressing and baling. But this circular economy mindset of aiming to add value to collected waste is not yet widespread in the waste sector.

Nevertheless, collection and preparation for reuse is still not a profitable business without municipal subsidies in the form of cheap labor. Hence, it could be questioned whether organizing reuse will be widely adopted by other local waste management companies, municipal authorities or private businesses. As the value so far mainly resides in its environmental and local social benefits, there is reason to place preparation for reuse activities within the authority of the municipalities. Political and regulatory measures to support reuse should be justified not only by its environmental and financial value, but also by the social value generated from the activities (Curran & Williams, 2010). Future experiments with value-adding activities, such as those presented in Ordoñez and Rexfelt (2017), will indicate whether the economic benefits of preparation for reuse will become more promising.

It is often assumed that there is an economic value creation potential associated with increased material and resource efficiency gains in a circular economy. Moreover, circular economy advocates suggest that the largest value creation potential lies within reuse. The results of our case study nuance our understanding of what a focus on value creation implies for municipal waste managers.

From the combustible waste fraction at a recycling center, the four major fractions to be sorted for recovery are *wood*, *cardboard*, *plastics* and *items for reuse*. *Wood* provides no additional revenues beyond the savings from the incineration tax, no additional jobs, and the environmental benefits from the recycling seem to be missed due to a misalignment with the energy sector burning virgin wood. *Cardboard* provides an income and is thus the only profitable fraction to collect and recycle. Socially and environmentally, though, cardboard collection does not provide any local value. *Plastics* amount to a deficit locally, do not entail additional jobs and the environmental benefits are questionable. Thus, the most interesting fraction in terms of local value creation is *items for reuse*. Accounting for 3.23% of the total waste collected at the recycling center, reuse plays a significant role in terms of tonnage diverted from other waste fractions lower in the waste hierarchy (landfill, combustible and recyclables). Collection for reuse moreover enables job creation locally, as the collected items need preparation for reuse and selling in the reuse shop. Thus, for the local economy and prosperity, preparation for reuse adds more value than selling the items for material recycling or incineration.

Preparation for reuse is a promising way to add value to waste products and capture value locally. Looking through the circular economy lens, the focus on adding and capturing value from waste requires a shift in contemporary municipal waste management. Moreover, this study points towards the importance of broadening the conceptualization of value when applying circular economy principles.

7.2. DEVELOPING VALUE CREATION ACTIVITIES IN AVV

In this section, I describe and analyze the process that led to the establishment of the prepare-for-reuse workshop GodtGjort (described as BM6 in chapter 4) in which waste is transformed into new products at AVV. A process also called “up-cycling”. Up-cycling is defined as the activity of using discarded products to create new products of higher quality and value (Oxford Dictionary). Transforming discarded products into new products through a creative process is not uncommon (Ordoñez & Rexfelt, 2017), but it is rather uncommon to systematically transform post-consumer products, that has been collected at municipal recycling centers, into new more valuable products under the auspices of a municipal waste management company. In this way, preparing post-consumer product for reuse becomes a waste treatment solution that postpones the need for other waste treatment solutions, such as recycling and incineration.

Designing products from waste is a less investigated process, but as the focus on circular economy has increased, more research is emerging within design with waste. The notion “*Waste is what is left, when imagination fails*” has among other been used by the previous Danish minister of the environment, Ida Auken. Ordoñez and Rexfelt, 2017 question whether this is actually true. They find that there are many other and more pressing challenges related to the design process when designing with waste than the challenge of getting the idea for a product from waste. They particularly point towards the need for thorough and reliable material knowledge and knowledge of the context in which the product development takes place (Ordoñez & Rexfelt, 2017). Given the fact that their study was based on design with industrial waste, i.e. waste types that are much more standardized and homogeneous than municipal waste, the challenge of designing with municipal waste must be expected to be even more challenging.

From 2014 to 2017, AVV has experimented with up-cycling in various ways, the result being that they now operate a workshop in which waste is transformed into new products that are sold on the market. In other words, AVV has developed a circular business model in which the resources in waste are utilized again and value is created (cf. the definition of circular economy). In this analysis, I aim to investigate the process of developing this circular business model (including lessons learnt from failed attempts), rather than the specific product design processes (as investigated by Ordoñez & Rexfelt (2017)). This is in order to put emphasis on how the development of a circular business model can be facilitated from the outset in a waste management company rather from a private company wishing to design from waste. The major difference between these two outset is that a private company can independently chose which waste materials they wish as a supply, whereas the waste management company is restricted by the supply of waste materials that they already get. In order for a circular business model to become an alternative to other waste treatment solutions, it needs to take point of departure in the actually supplied waste.

However, as most business model innovation theories emphasize the importance of taken point of departure in the demand side in order to deliberately aim the value proposition toward specific consumer wants or needs (Teece, 2010), attention to the demand side also needs to be taken. Municipal waste may be heterogeneous, but it is also comprised by a large variety of materials and post-consumer products. Hence, there is room for selecting particular waste materials for designing products.

The remainder of this chapter builds on field notes, observations and ethnographic interviews in AVV, and is presented as a case study narrative. The more specific aim is to investigate how and what the organization AVV has learnt about developing circular business models, and what general learnings can be extracted from this. More specifically, the chapter aims to identify

- how the organizational decision making process has unfolded
- drivers (external and internal in the organization) for developing this circular business model
- characteristics of the process of changing focus from waste treatment to circular business models
- experiences from failed attempts to explain the journey towards a circular business model

7.2.1. GESTATION PERIOD

Prior to innovations, are often a period of several years in which people are engaged in different activities that set the stage for the innovation (Van de Ven et al., 1999). In hindsight, AVVs engagement in art and use of waste in the interior decorations can be viewed as such gestating activities. These activities were not intentionally aimed towards developing the circular business model, but they contributed to setting the stage for the innovation by building up new meanings of waste in AVV.

7.2.1.1 Art from waste and a playful organisational culture

AVVs interest in developing products from waste goes further back than 2014. Before any talks of circular economy had reached AVV, there was a “*strong interest in exploring what could be done with waste*” (communication manager). “*Waste is more than calorific values and recycling rates; waste also pictures common human aspects and conditions*” (innovation manager). More specifically, introducing waste as material for art has interested some of the employees in AVV, particularly the innovation manager and the communication manager. “*Using waste as a material in art can provide new ways of perceiving waste, and establish new channels to communicate and discuss with citizens*”, says the communication manager. The first event in AVV, where waste was used in the creation of art was in 2001. The connection between art and waste was established not only because AVV actively encouraged it, but also because they were approached by some artists who were

fascinated by waste as a material. Following the collaboration with the artists, AVV also arranged creative workshops for citizens, and has done so ever since. Every year, 1-3 workshop events are arranged. This means that the circular potential of waste has been evident in AVV for many years. In the beginning, AVV saw it as means to strengthen their communication (and make the citizens more aware of the values in waste) and later the business potentials in waste were explored. The figures 7.3 and 7.4 present some examples of art made of waste in AVV.



Figure 7.3 Tapestry of wires, by Marit Benthe Norheim, 2004. Is exhibited at the end wall of a meeting room in AVV.



Figure 7.4 Photo art made of photographs from AVVs premises. The art work is exhibited on the end wall in AVVs conference room. Made by the local artist Inge Tranter in 2013

In 2013-2014, the administrative buildings of AVV was renovated, and in that process, an interior decorator was hired to decorate the offices with waste materials. Using waste as a material for decorating the offices was a way to demonstrate that waste can be a resource and have value when used artistically.

The value that this provided AVV related to the communication with citizens, public relations, local community engagement, and providing the employees and local citizens experiences. However, like an employee questioned the need for circular business model innovation, the question of the rational use or value of AVVs engagement in art could also be posed. What the engagement in art related activities really reveals about AVV is a playful, experimenting culture, and a disregard of the risk of failure. *“It’s not like the board has been sitting at a board meeting discussing a point on the agenda whether we should engage in art or not. Waste and art was*

just something that we have found fascinating and then it has evolved from there” (innovation manager). This quote reveals that personal and professional interests in waste, rather than rational considerations at management level have driven the engagement in art from waste. It also shows that experimentation, organizational learning and change are initiated at the operational level and thus based on a bottom-up approach, where employees in the innovation department take the initiative to engage in or to develop untraditional activities.

With the interior decoration, AVV has received a lot of attention from media, local organizations, and organizations in the waste sector. Visitors are guided around the offices and shown the art works and decorations, and some have even come with the sole purpose of seeing it. As Schein (2010) writes, the visible upper layers of an organizational culture are the artefacts that employees, customers and newcomer meet. They create a first impression of the culture. Artefacts are important in the collaboration with external partners too (Schultz, 2014). The art and decorations have become a symbol of the changing understanding and meaning of waste within AVV of waste as a resource (cf. *“everything speaks”* in chapter 4). As a social constructive perspective on organizational culture emphasize, people are motivated by and act from the outset of meaning, and at the same time they continuously create meaning for themselves and others (Schultz, 2014). Decision-making processes are about meaning. However, meaning is not necessarily the predefining aspect, but rather the result of the process (Kjær & Vendelø, 2014). The integration of waste as a material for art and interior decoration is an example of how new meaning has been created in AVV, but also for other external stakeholders visiting AVV. The attention and interactions related to the interior decorations has moreover contributed to developing and manifesting AVVs organizational identity as innovative and frontrunners.

It is worth noticing that the consequences of this use of waste, including the increased attention and changes to the organizational identity, was not foreseen. Decisions to engage in art and decorate with waste were not speculative and made because of some predefined meanings and calculated goals nor as the result of careful considerations of alternatives. Rather they were the result of creative linkages between problems (increasing amounts of waste and linear production), solutions (using waste as a resource), participants (e.g. employees with a personal interest in art) and decision events (the renovation of the buildings open the possibility for experimenting with waste as interior), with new meanings emerging (based on Cohen et al. 2012)

7.2.1.2 Products from waste and their circular business models

Before the circular economy concept was introduced to AVV, AVV had already made experiments with art and waste, and there was a culture that allowed decisions and change to emerge ongoing and rather anarchistic. The existence of this culture in AVV meant that to the employees experimenting with product design from waste was not in any way controversial. Yet, creating products from waste differs from engaging in art particularly when a circular business model is to be developed as a waste management solution supplementary to traditional waste management. Developing and implementing a new business model is not a one-time event (like the interior decoration), but an ongoing operation. The process that I aim to describe and extract learnings from stretches from the beginning of 2014 to November 1st 2017, where AVVs refurbishment branch GodtGjort was launched. During these 3½ years, a learning process has taken place, a process of experimenting and developing knowledge and competences. The following will provide insights into this learning process and highlight some of the key learnings on how a waste management company can develop circular business models.

The following narrative is built up around temporal sequences of events, junctures, hurdles and attempts concerning the development of products and business models, thus inspired by innovation journey literature (Van de Ven et al., 1999). It is to be read as a chronological learning process in which learnings from each event or attempt is continuously added to the previous learnings. After each description of an attempt, I sum up what the main learning from it was. Before beginning the description of the attempts, there are some contextual elements that are important to the analysis, and thus important to make clear. Firstly, the innovation journey participants mainly consists of the employees in the innovation department and the management and to a minor degree employees in other departments. The employees in the innovation department have other operational tasks, and the innovation and development tasks only account for app. 20 % of the work-time. This means that time and resources for innovation are limited. Secondly, there was not a clear and specific aim to develop a circular business model in the beginning. The aim was more broadly to develop solutions in which waste was seen as a resource (thus not pointing specifically towards any particular circle of the circular economy). The outcome of the process, i.e. GodtGjort, was not imagined at the outset. This is a common feature of innovation processes (Van de Ven et al. 1999) maybe due to the fact that they are often mapped and analyzed in hindsight. The outset in AVV was a curiosity and fascination similar to the above described engagement in art regarding the “*what could be done with waste*”, maybe further prompted by the emerging thoughts about the circular economy.

7.2.1.3 Nulskruld Projects

There were also other such activities, projects and events, which have contributed to setting the stage. AVV had run different citizen awareness projects throughout the years. These included

- “117 really good reasons” (DA: “177 m ggode grunde”): a sorting experiment in which citizens were invited to suggest new waste fractions to be separately collected. The aim was to achieve a separate collection of 117 different types of waste in one of AVVs recycling center.
- “Experiences with waste”: AVV produced more than 50 small films about waste. These can be found on youtube. They present waste in funny and creative ways.
- *The Nulskruld projects*

The Nulskruld (zero waste) projects were citizens awareness projects. The first project was run in 2013 in collaboration with Aalborg University and a communication bureau (Tankegang), and it aimed at engaging citizens in sorting and preventing waste in the households. In 2014, a second round of Nulskruld was carried out, this time as a Zero waste village (Nulskruld landsby) in which one village should minimize their daily discard as much as possible throughout one year by sorting for recycling and preventing waste in various ways. The Nulskruld projects were experimental, and particularly the second round was developed ad-hoc throughout the year. All the employees in the innovation department were to various degrees engaged in the project, and through this engagement, new collective reflections and learnings were generated. Among other, it was during this project that a common understanding of the waste hierarchy definitions and principles were established. Moreover, the project generated some of the first considerations about how waste could in practice be used as a resource in other ways than through material recycling.

In December 2013, I was employed as an industrial PhD in AVV. I will also include this event as contributing to setting the stage for circular business model innovation. Even though, the employees knew about sustainability and the concept of the circular economy, a larger awareness and knowledge of what the concept implied may have been developed with my employment in the company. For instance, a deeper understanding of the principles of the waste hierarchy entailed a larger focus on reuse. More specifically, the reuse shop was prioritized by employing a new manager. The reuse shop manager points towards my contribution to developing a strategy for the reuse shop in 2014 as one of pushes in the process. This was the first time that the concept of sustainability was actively used to formulate the strategy. During this process (the first half year of 2014) there was a focus on how AVV could increase reuse of a larger variety of post-consumer products. For instance, the

first thoughts about refurbishing WEEE and organizing collection and sales of building materials appears in a document from February 2014.

In addition to these events and activities that I have identified as contributing to initiating the innovation journey, there have been several others, which are not visible to me as a researcher. Six employees from the innovation department have read earlier versions of this chapter and commented upon it. During that process I became aware of events and elements that had played a role in the innovation journey too. Some have been included in the chapter, but the innovation journey description does not make a 1:1 account of all the events and elements that may have had an impact. Employees have attended conferences and meetings, received input from the elsewhere, that have generated new ideas, new values and inspirations. It is the cumulative effect of these activities, events, input, reflections etc. that has contributed to stimulating the innovation.

7.2.1.4 First attempt (Spring 2014): Fishing nets

Triggered by the Nulskrald project, the innovation department had considered the possibility of product development with waste as input material. There were many activities in the Nulskrald project, and one of them was to experiment with product development. It is important to stress, that this attempt was not of major focus in AVV or in the Nulskrald project. Two employees initiated it, and after a while I got the task. As such, not much time and resources were set aside for it, and it was not considered one of the main activities in the Nulskrald project.

At a meeting, three employees made the first discussions about products from waste. They began by identifying of a particularly problematic waste fraction so that the environmental benefits from reusing it in a product would be maximized. After brainstorming ideas and discussing these, fishing nets were chosen. At the time, fishing nets were disposed of in landfill, because when incinerating the fishing nets they got tangled in the machinery and caused break down in the energy production. Moreover, there were no recycling possibilities at the time.

No one in the innovation department had product design experience or skills, and for this reason an external designer was invited to make an attempt with making fishing nets to a product. A meeting was arranged with the designer, and



Figure 7.5 Drawing of swing made of fishing net

product ideas were discussed. Finally, it was decided that the product to be made from the used nets was going to be a swing. Thus, the designers went home with the task of developing a swing from the nets.

Two weeks later, the designers sent a product proposal. They had drawn ideas for swings from old fishing nets. The drawings depicted two models of a swing (one is presented in figure 7.5).

The designers did not make a prototype, and did not intend to. AVV now had some drawings of swings, but no idea whether they could actually be constructed in practice. In the same way that AVV did (and does) not encompass design competences among their employees, they also do not hold carpentry or joiner competences (and with good reason, being waste managers). At this point in the process, I got the task to carry on the project. I contacted a carpenter and asked if he could make a prototype. After some adjustments to the drawing (which included a round ring of wood, which would be difficult and expensive for the carpenter to make), he agreed to make prototype.

This point in the process resembles the art related activities that AVV had engaged in previously. In a similar way, that an artist makes a piece of art from waste through a creative process, a designer had created a product idea that, if possible, a carpenter could fabricate.

It was also at this point in the process, that I began to realize how comprehensive the process of business model innovation would be, and that it reaches far beyond product development. Simultaneously with the dialogue with the carpenter, I began considering other elements of the business model canvas for the first time. On the value delivery side of the canvas, there were questions regarding whether the swing would be comfortable to sit in, whether there would be a market for it, who would be the main customer segment, what a potential market would require (safety standards, for instance). On the value creation side, there were questions regarding how the swing should be produced and who should produce it, and what the cost for production would be. Additionally, the question arose of whether a municipal waste management company is even legally allowed to operate such type of business. Business model thinking was not a core competence of mine, nor among the employees in the innovation department, as these types of considerations were completely different from work tasks usually conducted in the department. Thus, in addition to the missing design and craftsman skills, a lack of business development competences were also a barrier to circular business model innovation in AVV. The task of developing a product from waste grew to a point that seemed unmanageable within the time and resource frame that was set aside for the project. At that point, we decided to terminate the project.

The case of the fishing net swings exemplifies that it may be difficult for a waste management company to shift the focus from waste management to value creation. Yet even though the project was terminated, the fishing net swing project provided a set of first insights into the challenge of developing circular business models from the outset of a waste management company. Firstly, the smallest challenge is getting the idea for a product (as also noted by Ordoñez & Rexfelt (2017)). Secondly, there was a firsthand realization of the lack of certain competences in AVV, i.e. a lack of “key resources” and the need to engage with the right type of “key partners” (cf. elements of the business model) when producing a product. Thirdly, there was a realization of the array of elements in the business model that would have to be dealt with in order to actually bring the swing from the paper drawing stage to the market, and the extent of this task. Whether the fishing net swing would have been suitable for a circular business model is still unclear, but at that time in AVV we were not yet ready to pursue the idea further.

Learning 1a: The challenge is not to get an idea for a product, but to build up all the elements of the business model and make them fit to become a viable business.

Learning 1b: The traditional skills used in waste management differ from the skills and competences needed to develop circular business models. Lack of professional competences such as product design, craftsman skills and manufacturing skills.

7.2.1.5 Second attempt: Endeavors to establish collaboration with production school

Having realized that the challenge of converting waste to a product not only resides in getting an idea for a product, but also to handle the other elements of the business model, we decided to approach the matter from another angle than the product design. Production competences and facilities is (naturally) not present in the waste management in AVV, and we decided to explore how to get a potential product from waste produced (part of the left side of the business model canvas) rather than taking point of departure in product development. In the local area of AVV, there is a school for disabled people (such as people with downs syndrome) in which the students produce different things and has production facilities to cut wood, metals and the like. They produce things in larger quantities on order from other companies, but also develop simple products to be sold on local flea markets and on demand. One of the employees in AVV, P, knew the school manager personally. P and I went to visit the production school and brainstorm with them on product ideas that could be made from waste. The manager liked the idea, as they were always looking for things to produce and thus activate the students with in order to develop their practical skills. Shortly after the initial meeting, the manager visited AVV to have a look at the waste materials to see if this could generate any new product ideas

for them to produce. The manager was stroke by the heterogeneous character of the waste. In order for him and his school to make a product, the input material needed to be standardized and homogenous. The lack of standardized waste became the end of this second attempt, but provided AVV with a new learning:

Learning 2: the need for standardized waste types as input material and prototypes for developing a business model or a production unit that can handle heterogeneous materials.

After this failed attempt to establish a collaboration with the production school, the idea of developing a product from waste was parked for approximately a year. I began the literature study of waste prevention and shortly after went on maternity leave. The other employees were busy with other activities in the Nulskrald project besides their operational tasks, and generally, the Nulskrald project tore on the employees' resources.

7.2.1.6 Third attempt: Inviting Designer and Entrepreneurs and encouraging entrepreneurship (May 2015)

AVV frequently arrange citizen events with different themes. As the interior design in AVV had attracted so much attention, a number of such events on this theme was carried out. Citizens could for instance come and experiment with creative processes of making things out of waste, such as leather purses, refurbishing old clothes, making art of waste materials. This might have spurred the idea among some of the employees in the innovation department to take up the idea of product development again, but approach it in a different way. Two employees in the innovation department decided to try to setup the stage for external partners to develop products as well as a business model on commercial terms with AVV being the supplier of cheap or for free waste materials.

The two employees organized a workshop in collaboration with the local business council, who provides consultancy in entrepreneurship, and invited designers or any creative people interesting in developing products from waste. Only eight interested people showed up for the workshop. As an introduction, the local business council gave a lecture on entrepreneurship and business model thinking to prepare the participants for this part of the task. The participants were then provided the opportunity to find materials among the waste, develop products and finally discuss a business model with the business council consultant.

The products that came out of this process had one characteristic in common: they were all handmade unique creations that could not be standardized and mass produced. The participating designers enjoyed the creative process of for instance, refurbishing furniture. These processes took point of departure in unique post-consumer item found in the containers and remade them with a unique looks. This

process of refurbishing furniture is time consuming, and requires that the employees conducting the refurbishment have a sense of aesthetics. Thus, not a process that could be scaled up as an alternative to other types of waste treatment. Moreover, the waste products that the participants chose as input material tended to be products that could have been sold in the reuse shop without refurbishment, however to a lower price. The question was if the added value of the refurbishment process were commensurate with the time, effort and materials put into the process.

When the entrepreneur project ended neither of the designers had managed to develop a viable business model. Many nice prototypes had been produced, but they were unique and not reproducible. Moreover, the input materials were in many cases some of the most easily sellable products from the reuse shop. Thus, the refurbishment process would only add a marginal value to the waste compared to the sales in the reuse shop, and not entail a more resource conserving solution than the reuse shop could provide.

Learning 3a: Giving access to external designers with own businesses resulted in cherry picking from the reuse shops sellable post-consumer products. To establish a circular business model input material for products should rather be waste for recycling or incineration to entail a resource conserving benefit.

Learning 3b: The time and resources put into refurbishing or remanufacturing each post-consumer product must correspond with the value that can be captured from the sales of the products.

7.2.1.7 Fifth attempt: Bike refurbishing workshop and grabbing opportunities

The idea of making a workshop for WEEE was inspired by the Flanders Kringwinkel. As described in chapter 6, the municipality's job center welcomed the idea of a workshop in which socially vulnerable people could be trained for job skills, language, integration to a work place etc. The reuse shop manager had several meetings with the job center. However, a requisite for the job center to engage a closer collaboration with AVV was that AVV should develop clear project plans, business descriptions and job descriptions. As the workshop was not developed yet and there was many uncertainties about how to organize it, what waste input material to use, what products to produce etc., developing a business model description was not easy. As the reuse shop manager put in retrospect: *"It was hard, because we did not know what it was that we going to make. We had an experimental approach, and we could not have made a business description or a plan at that time"*. Because of the inability to develop business plans and job descriptions, the collaboration with the municipality's job center was not initiated and no workers engaged, and thus no workshop could be established.

In the spring of 2016, an employee from the nearby refugee center came looking for work for some of the refugees, who were getting frustrated in the centers by not having anything to do. More specifically, he had two refugees whose competences he suggested could be useful in AVV. The first one, an Iraqi man called Yaseem, had mechanics skills and could refurbish bikes and smaller simple engines. The other one, an Eritrean woman called Senait, had good language skills and was a quick learner. In his words, they were ready to begin tomorrow, the sooner the better.

“And then S [CEO] and I looked at each other and said: Yes, let’s just do it! That is the way AVV works. And then we started” (reuse shop manager). In April 2016, Yaseem and Senait were hired as interns for four months. Senait’s tasks were in the reuse shop, and Yaseem was hired to utilize his mechanics skills. Actually, the possession of these skills became decisive for what post-consumer products were to be refurbished in the workshop: bikes and lawn movers. Repair of bikes and lawn mowers may not be the most innovative and exceptional waste based product, but the bikes were easily sold in the reuse shop, thus employing the sales channels that AVV already had. The demand for used bikes was so high, that new initiatives had to be setup in the recycling centers for collection of more bikes, as well as collaboration with local housing associations to collect discarded bikes. During the first 6 months, the sales of used bikes increased from app. 20 to 150 per month. Moreover, the value of each bike was increased by the refurbishment process. The income from the sales of bikes increased from 60,152 DKK in 2014, to 165,382 DKK in 2016, and 189,072 DKK in 2017 (Jan-Oct.). The bike repair workshop was such a success that it was enhanced with two more employees.

Chance plays a significant role in launching an innovation journey (Van de Ven, et al. 1999). The contact with the asylum center was one such chance that arose without planning. AVV grabbed the chance. This chance can be considered to be what Van de Ven et al. (1999) calls a “shock” or a trigger. Shocks are not necessarily negative (ibid). The idea of setting up a workshop for refurbish WEEE or other products had been in AVV since the beginning of 2014, but the arrival of a new worker (Yaseem) made it easier to act upon and served to concentrate the attention in AVV towards the establishment of the workshop.

Learning 5a: Experimentation and courage to grab chances, when they appear, are more decisive than careful time- and work plans.

Learning 5b: Begin small with low-tech repair using existing sales channels

In order not to create unnecessary conflicts with the local bicycle shops, all these were contacted. *“We do not want to distort the competition. We rather want to collaborate. Luckily, the bicycle shops agreed with us, that the customer segments that they sell to are not the same as the ones who buy a used bike”* (workshop

manager). For this reason, AVV does not provide bike repair as a service for private customers, as this would be in direct competition with the local bicycle shops.

During the spring and summer of 2016, the bike refurbishment workshop turned in a success. However, if the labor input to the refurbishment process had been on commercial terms, the revenues from the sales would not have been commensurate with the expenses. Only by sharing the labor cost with the municipality, this new waste treatment operation could be justified in narrow business economic terms. Even though it can be argued that some value from waste was created, the economic value capture did not exceed the economic input that enabled this value creation. However, waste management is not a societal task mainly aimed at creating economic value, but a task that primarily aims at solving the environmental challenges related to waste. The priorities of the waste hierarchy are mainly based on environmental, not economic considerations. Waste management has traditionally been a cost center, and in this perspective, it is not controversial to economically subsidize refurbishment as a waste management option. However, with this argument, we move back to the previous waste paradigm where the main focus is environmental protection, not economic value creation from the circular economy perspective.

From a sustainability perspective, the bike refurbishment workshop (as well as the reuse shop) creates a wider range of value than simply economic and environmental, as also discussed in Article C. The employment of Yaseem and Senait turned out well, and both of them performed well in their jobs (Senait was from August 2017 employed on commercial terms to assist in the reuse shop and to mentor new employees with refugee background). Apart from the enabling of the workshop, this integration of refugees in the company plays a role in the social sustainability performance of the company. It creates value for the local community and the municipality.

7.2.2. DEVELOPMENT PERIOD

7.2.2.1 Prioritizing the workshop

Additional resources and skills for further developing and organizing the workshop was needed. The fact that the bike refurbishment had turned out rather successful may have given the final push to the decision to employ a person for this particular task in a one-year position with possibility of extension depending on the outcome of the process. In November 2016, Manuel, a 26 year old man with Lebanese background, was employed. His educational background was occupational therapist, and with his Arabic language skills, he would be able to communicate better with potential future refugee workers and act as an integration mentor for these. His main job function thus was to develop and operate the workshop and to mentor the future employees to enable them to build up skills and competences. From this point the

process really began to roll and enter what Van de Ven et al. (1999) calls the proliferation phase.

So far, circular business model innovation had not been a strategically prioritized task, but an additional task for employees in the innovation department and the reuse shop to experiment with. Having one employee, whose sole task is to organize and establish the workshop made a huge difference.

The bike refurbishment workshop was expanded with two additional workers, and with the employment of Manuel further expansion of the workshop had now become a strategic aim for AVV.

Learning 5a: The importance of prioritizing skilled labor whose time and resources is solely devoted to the task

7.2.2.2 Sixth step: Textile workshop

Textiles as a waste fraction has received increased attention in the waste sector during recent years, due to its high and increasing amounts. Consumers on average buy 60 % more clothes items today than they did in 2000, and they keep them for half as long (Cobbing & Vicaire, 2016). So far, AVV has managed to sell 30-50 % of the collected textiles in the reuse shop. The rest is sold to the Salvation Army, who sends it abroad to large international facilities where second-hand clothes is sorted and prepared for sales⁹. The value capture from the amounts sold in the reuse shop ranges from 10 DKK per kg to 500 DKK per kg depending on the quality of the clothes, whereas the Salvation Army only pays 1.60 DKK per kg.

The reuse shop manager and the new workshop manager began considering if there were possibilities to refurbish or remanufacture textiles in the workshop. They were moreover in continuous dialogue with the job center, and when a couple of Syrian refugees with tailoring skills appeared, the reuse shop manager and the workshop manager grabbed the chance and began setting up a tailoring workshop without knowing exactly what was to be the outcome. The hope was that the tailors could develop new ideas and products with the waste textiles.

The Syrian couple was very skilled tailors who had run their own wedding dress tailoring shop in Syria for 20 years. They enjoyed being provided with the opportunity to use their skills again. In the workshop, they made bags, pillows, dresses, jackets etc. with fine details and of fine quality. However, the things they

⁹ AVV has no knowledge of the further fate of these textiles. They assume that most of it is prepared for reuse, because the Salvation Army pays for the clothes. However, they also assume that some of it is recycled or incinerated. If AVV cannot sell it, it is fair to assume that there is a limit to how much the Salvation Army and other charity shops can sell.

produced were not typically Northern fashion, and there was no demand or market for these things. For this reason, the managers decided to develop a collaboration with designers who had knowledge of the Danish market for fashion and could assist the textile workshop in a way that would increase the value creation for a local customer segment.

Learning 6: Tailor (or other types of craftsman) skills needs to be supplemented with knowledge of market desires.

The new workshop manager had good contact-making skills. He got in contact with a Danish textile brand making high-end women fashion of old Indian saris (Sidsel Edelbo). He invited them to use AVVs workshop labor and used textiles. Sidsel Edelbo liked the idea, and ordered a production of sewing some prints on the back of old army jackets. This gave the textile workshop work to do, but did not provide any upcycling solutions for AVVs own collected textiles. Hence, there was an agreement internally in AVV that this task should only be done in order to get the experience and to possibly “open doors” for future collaborations. From the army jacket task, followed the idea of refurbishing denim jackets collected in AVV in a similar way. AVV started to collect denim jackets to be refurbished in the workshop. At present, 30 jackets have been collected and are ready to become refurbished. Collecting the denim jackets has been time consuming, and the reuse shop manager expresses concerns about how high the price for the final refurbished jackets must be to compare to the costs of sorting them out and refurbishing them.

Two similar collaborations with established market actors have also been initiated. One of these is with a baby clothes brand Plyssky, and in this collaboration used textiles will be used to produce baby clothes, which will be marketed and sold by Plyssky.

Learning 6b: Collaboration with established designers and brands can create a pathway to the market

Learning 6c: The price of the refurbished products must compare to the time and resources put into the preparation process.

7.2.2.3 Seventh attempt: Workshop cloths

In the case of cloths, the managers (reuse shop and workshop) put much effort into the development of the business model. Prior to the actual prototyping, they made small experiments with collecting textiles of cotton in order to investigate the potential. Additionally, they investigated the local consumer market for workshop cloths, interviewed local workshops like auto mechanics. They found out that many local workshops like auto mechanics used paper cloths, but a large part of the market for workshop cloths were covered by one business actor leasing cloths and

taking them back for wash. This service cost 16 kr. per cloth. The cloths were produced in Belgium. This meant that a new business for workshop cloths made of waste textiles would compete with an existing business.

AVVs workshop cloth business model: AVV separately collects waste cotton textiles (such as waste bedsheets and linen) with no market value. They invested in a machine to cut the cotton textiles into standardized sized cloths. This machine is easy to operate for unskilled labor. The cloths are sold to local workshops. The sales channels comprises already established collaborations with local industry, AVVs own Facebook page and monthly letter to citizens and industry.

This circular business model cascades the textiles into use for one last time. After use, the cloths have to be incinerated due to the oil used in the workshops.

In this case, AVV has come far in developing circular business models. The process of building up this business model covered an investigation of all the elements of the business model before establishing the workshop. However, with this business model AVV also encounters a new dilemma: This workshop cloths business competes directly with an identified established market actor. Even though the business model enables one last time of use of waste textiles, the environmental effects are not clear. Which solution is better: high quality cloths that are taken back for wash, or old fabrics that would otherwise have been recycled into fibers or incinerated? Both of the models could be characterized as circular, but which is more environmentally friendly?

The issue of competing on market terms is a not yet resolved challenge for a municipal waste management company embarking upon circular business model innovation. AVV using cheap labor and that is what makes the cloth business model viable.

Learning 7a: Investigating local market and business model opportunities beforehand is beneficial.

Learning 7b: Collaboration with local actors is key to success

Learning 7c: New circular business models with waste as input material might compete with other businesses. Some of these may even also be somehow circular.

7.2.2.4 Human reactions to the innovation process

It is a common aspect of innovation processes that innovation participants and managers become highly emotionally involved (Van de Ven et al. 1999). During AVVs innovation journey the participants have been emotionally affected in

different ways at different stages, and these emotions have played an important role in how the process has evolved. For instance, the first Nulskrald project created joy and euphoria among the employees. It was a short (five weeks) project. It provided the participants with new insights and learnings about waste sorting, and maybe most importantly it was received positively by the local community with a high level of citizen engagement and public attention. By the end of the project, the employees felt happy and inspired to continue this new path of innovation.

The second part of the Nulskrald project lasted much longer (a year). During this project, the employees encountered more challenges and setbacks, and at times, there were feelings of uncertainty of how to proceed, frustrations and even exhaustion. Personally, I felt frustrated during the fishing net swing experiment, because it turned out to be much more challenging and time consuming than I had expected. By the end of the second phase of the Nulskrald project, some employees expressed a wish to have a break with experiments and innovation, and just focus on the operational tasks that some felt they had underperformed on.

Generally, the idea-phase of the individual attempts was characterized by emotions like excitement, joy and anticipation. In the middle period, frustrations would come when encountering challenges, and finally when the attempts were ended feelings of closure arrived. This pattern was also identified by Van de Ven et al. (1999).

It is important to acknowledge the role of human emotions. Emotions are important to idea generation, to motivation, and to the learning process. Much learning was gained through the troublesome phases. Yet, there may also be a limit as to how much energy participating employees have to continue innovation, and this adds to the length of the innovation process.

7.2.2.5 Implementation period

Implementation of innovations happen concurrently with the development period (Van de Ven et al. 1999). This is also the case in AVVs workshop. The workshop facilities are established, and product lines (bikes, cloths, baby bibs, children's clothes, etc.) is continuously developed. Common to all the products is that their development and production are enabled through collaboration with external stakeholders: the municipality's job center enables employment of the right type of workers, and designers and brands enables the design, branding and bringing the products to the market. In November 2017, all the new refurbishment activities in the workshop was presented on a new webpage to be branded under the name GodtGjort. GodtGjort is also the name of a commercial foundation, that AVV has established in order to enable public-private partnerships like the collaborations with the before mentioned stakeholders.

The workshop manager spends approximately 30 % of his time building and maintaining contacts with stakeholders to collaborate with. The rest of his time, he spends on mentoring the workers and organizing and administering the workshop.

A common feature of the implementation period identified by Van de Ven et al. (1999) is that performance criteria used by the participating innovators change. In the initial phase of AVVs innovation journey, the main performance criteria for evaluating success was to “move up the waste hierarchy” and thus achieve an environmental advantage from refurbishing some environmentally troublesome waste, such as fishing nets, rather than incinerating or disposing of it. Though not so explicitly expressed, the main performance criteria was to reduce environmental impact. This focus has shifted, and now the main performance criteria seems to be to lift people out of unemployment, in other words to create social value at local level. This may be a result of some of the challenges and possibilities encountered through the process: taking point of departure in an environmentally troublesome waste fraction was difficult. Economic value creation from the production is also difficult. The one constant positive outcome is that the workers are provided with a job in a safe environment, where they can build up skills, practical as well as language, and competences to engage in a workplace, and receive mentoring and help during their work. AVVs new task of social integration has moved from being an enabler of a circular business model to becoming the aim itself.

7.2.3. EMPLOYMENT AND THE WASTE HIERARCHY

The differences in employment levels in different areas of the waste management in AVV incentivized an analysis of the connection between number of jobs and amounts of waste managed in the different treatment types of the waste hierarchy. Figure 7.6 shows how much waste treated at the different stages of the waste hierarchy employs one person. It is a rough estimate with large uncertainties, as described below. Nevertheless, it indicates that the order of preference in terms of environmental benefits (which the waste hierarchy is originally based on) also applies to the social effects. The same conclusion was found by the organization Rreuse (Rreuse, 2015). Moreover, as the sustenance of jobs depend on the economic balance of operations, this means that from a local societal point of view, the waste hierarchy is not just a guiding principle for environmental performance, but also the sustainability performance of the waste management solutions.

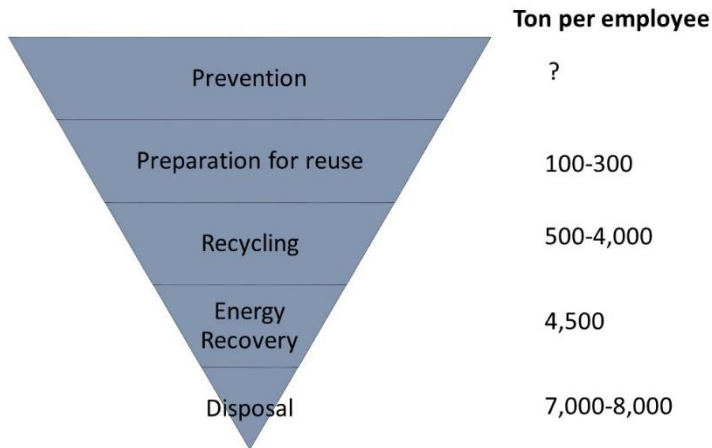


Figure 7.6 Rough estimates show that less waste can employ more people when treated further up the waste hierarchy.

Calculation method:

Disposal: 6-7,000 tons of waste is disposed every year. The economic accounting from 2016 shows that the wage bill corresponds to one job. Hence, 6-7,000 tons of waste disposed in landfill currently employ one person locally.

Incineration: Approximately 90,000 tons of waste is incinerated every year. 21-22 people are employed at the incineration plant. This varies slightly, and in some periods there is an intern. A simple calculation of tons per employed person shows that 4,500 tons can employ one person locally.

Recycling: Recycling is the most unreliable operation to make this assessment for. This is because AVV does not treat any waste for recycling, and much of it is treated outside Denmark. Jobs outside Denmark are not accounted for in this analysis, as we have no knowledge of it. Moreover, recycling covers various types of waste. For instance, it must be assumed that recycling one ton of paper requires completely different operations and labor input than recycling one ton of bricks. For this reason, a rough estimate of 500-4,500 tons have been made.

Reuse: This calculation is based on data from the reuse shop. The reuse shop sells 1,000-1,200 tons of waste, and employs 12 people. However, like recycling there are large differences in reuse of textiles and used bricks. Hence, a rough calculation makes an estimate of 100-300 tons per employee.

Prevention: estimating how much waste has been prevented is difficult, if not impossible, as discussed in Article A.

7.3. DISCUSSION

What can be learnt from AVVs innovation journey about how circular business models can be developed? In this chapter, I have described and analyzed how a circular business model innovation actually unfolded in practice in AVV. The learnings achieved can be grouped into two: 1) learnings within AVV about the barriers and opportunities of establishing prepare-for-reuse as a waste management solution, and 2) learnings of a more general character about circular business model innovation.

7.3.1.1 Learnings related to transforming waste into new products

From a waste management perspective, the innovation journey entailed learnings about how to develop and establish prepare for reuse activities to supplement other waste management solutions. I write supplement, because extending the lifetime of products will not displace recycling or incineration, but merely delay it. The learnings are written in bold throughout the previous sections, and in this section I summarize them. These learnings will most likely be applicable to other municipal waste management companies too.

Firstly, the need for building competences in AVV became evident. This included

- competences and knowledge about business models and circular economy
- creative skills for developing product ideas
- practical skills for refurbishing different types of product
- knowledge and understanding of market desires

In addition to these, competences and skills for networking and stakeholder collaboration was crucial, but to some extent, these competences were present in AVV prior to the innovation journey. Likewise, organizational skills to organize the elements of the workshop was needed, but was also present in AVV from the outset.

The experiences from AVV showed that in circular business model innovation it was not necessarily advantages to take point of departure in the value proposition or a certain waste type. Actually, it was the acquisition of a needed practical resource that enabled the practical experimentation with setting up the workshop. In this part of the experiment, it was easily assessed that there was a market for the bikes, because they could be sold in the reuse shop. Moreover, the bikes were taken from the container for metals recycling, whereby the solution was a step up the waste hierarchy, not just a step to the side, like the refurbishment of furniture that would have been sold in the reuse shop anyway. Similarly, the starting point for some of

the other refurbished products, such as the baby bibs and the jackets, was enabled through the stakeholder collaboration. These stakeholders already had an established market on which the products could be sold. The importance of stakeholder collaboration not only resides in the need for creating value, but also in the need for maintaining legitimacy. An example of this is the negotiations with the local bicycle shops.

AVV has traditionally collaborated with many different types of external stakeholders, but in the refurbishment workshop it is a new type of collaboration. This collaboration concerns the pursuit of finding ways in which the collaboration on the products created from waste can create value for both parts, and ways to legitimize this new type of managing waste.

7.3.1.2 Learnings related to circular business model innovation

Circular business model innovation in a waste management company may differ from circular business model innovation located in other parts of the value chain, such as original equipment manufacturers. However, by identifying some aspects of AVVs process and comparing to the theory of innovation journey (Van de Ven et al. 1999) and other studies, there are some general perspectives to emphasize. They relate to how:

- an overall vision at top-management level enabled and supported the bottom-up approach
- the bottom-up approach ensured employee engagement and motivation, strongly supported by the prevailing organizational culture
- the goal changed throughout the experimentation process (suggested by Christensen (1985) to be the rule rather than the exception)
- collaborations, bargaining and negotiations with external partners were determining for the success
- contact-making competences of some of the innovation participants enabled the establishment of these collaborations
- chance played a role

The first prerequisite for the circular business model innovation journey was the visions of the CEO. Without a CEO engaged in sustainability related issues and visions for transforming the company along these lines, it is dubious that GodtGjort would have been established. That being said, the innovation journey was not managed in its details by the CEO. Rather, the more specific ideas for experiments emerged from the innovation department, and the CEO supported such experiments despite the lack of clear goals. The lack of clear ideas of how to develop a circular business model placed the situation in square C of Christensen's (1985) planning square (chapter 2). This set the climate for the innovation journey and experimentation.

In a novel field like circular economy and circular business model innovation it may not be advantages to follow strict time and work plans towards a clearly specified goal. In AVV's case, one could have imagined a variety of possible solutions within the framework of the circular economy, but the commercial foundation GodtGjort and the particular refurbishing activities was not imagined four years ago. Likewise, it is at present not possible to say which circular business models AVV will operate in the future. Whether this variety of possible solutions is a general aspect of circular business model innovation is unclear, but for waste management companies collecting a large variety of different waste types, it will be a basic term. The fluid and continuously changing goals is, however, a common aspect of innovation processes, and it has even been identified in fairly simpler processes such as of energy renovation of buildings (Mosgaard & Maneschi, 2016). For this reason, it is fair to assume that uncertainty about end-goals, changing goals along an experimental process is a general basic term for circular business model innovation.

The importance of stakeholder collaboration and creation of shared value has been emphasized in literature on sustainable business models. Similarly, Christensen (1985) pointed out the need for bargaining and negotiation in situations with different goals among stakeholders. AVV has invited, communicated openly and negotiated for instance with the local reuse shops and the local bicycle shops in order to proactively affect the arena in which they operate and prevent opposition from such stakeholders. Bargaining and new configurations of collaborations with external stakeholders have been determining for the establishment of GodtGjort. However, establishing the right stakeholder collaborations around the right theme is easier said than done, and this has required much work and many tests of blind alleys by certain employees and managers in AVV. Initiation of collaborations seems to have become easier, the more “well-known” AVV's circular activities have become in the sector and in the local community. Moreover, personal qualifications and interests in contact-making activities among some personnel in AVV play a big role too. As the innovation manager replied, when I asked him why AVV often seek new collaborations: *“Because it is so much fun”*.

The pursuit to create circular business model in AVV has not been driven by traditional business logics, i.e. to enable profit maximization. The journey was initiated and continued in order to create awareness among citizens, and to create environmental and social value in a non-profit way. Nevertheless, considerations and assessments of GodtGjort's contribution to the three dimensions of sustainability have not been systematic and robust. Maybe the lack of making of systematic assessments is a tradeoff of the experimental approach. The question is if such systematic assessments could have been made prior to launching for instance the collaboration with the designer Sidsel Edelbo, or whether uncertainties about the actual outcome of this collaboration would make sustainability assessments impede the further experimental process. Assessing whether GodtGjort contributes positively to a sustainable development could be a next step for AVV. Due to the

interdependency between GodtGjort and other businesses (fashion designers) and the municipality (workers) such assessment should not be made solely on GodtGjort as an individual business model, but on the system of the interlinked business models. Only if that is done, will it be possible to understand and assess what value has been created for whom and on which dimensions of sustainability. This relates to the principle of “systems thinking” of circular economy described in chapter 2.

CHAPTER 8. INTERNAL PRACTICES IN AVV AND THEIR INFLUENCE ON ENABLING COLLECTION OF WASTE FOR REUSE

Two enabling factors for the circular economy has been highlighted: Business models and consumers (Kirschherr et al. 2017). These two enablers are, however, two sides of the same coin. In AVV, the consumers are not just consumers of the products and services, that AVV supply; they are also suppliers. Consumer behaviors are thus one of the first prerequisites for a circular economy, because their waste sorting behavior determines how much value can be extracted from waste.

For this reason, it is of great importance to a waste management company that citizens sort their waste when they deliver it at the recycling centers. Different measures can be taken for encouraging consumers to sort their waste well. Previous studies point towards the importance of guidance from waste workers.

In this chapter, I present a sub-study that I made in AVV investigating the practices of the workers in the recycling centers in Article D.

8.1. ARTICLE D

Title: “Working Practices at Recycling Centers and their influence on Rates for Reuse and Recycling”

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Status: Submitted to Waste Management and Research

Abstract

To support the development of a recycling society, EU member states are obliged to prepare 50 % the waste from households to reuse or recycling in 2020 (EU, 2008, article 11). In the Danish transposition of the regulation, the 50 % recycling target is applied to certain waste types. These are daily discard, paper, cardboard, plastic, glass, metals and wood. The site attendants at recycling centers play an important role in educating the citizens in good waste sorting for reuse and recycling. In this study, we investigate the working practices of the site attendants at 11 recycling centers and how their practices influence the quality of the waste sorting. The recycling centers are driven by a waste management company, whose visions and strategy concerns a “movement up the waste hierarchy”. Despite the green focus of the company, the reuse and recycling rates are low. We apply a practice-based approach to understand how the working practices of the site attendants affects the separate collection for reuse and recycling. The analysis shows that the working practices were initially developed to serve a different waste management system; one that mainly comprised incineration and landfill. The elements of this practice linger: The site attendants put emphasis on order and cleanliness, service (convenience for the users), and economic optimization. Not all of the common sayings and doings are supportive to achieve the government set target of 50 % recycling, and the daily practices in some cases work against the green visions of the company. The management unintentionally contributes to reproducing certain elements of the practice. We conclude that in order to change the practice so that they result in higher reuse and recycling rates, the site attendants need new meanings attached to the practice. Moreover, competences need to be developed. We emphasize that learning and development of new ideas for improved sorting happen within the daily practices.

8.1.1. INTRODUCTION

In the EU, waste management authorities are obliged to handle waste in ways that do not negatively affect the environment and human health (EU, 2008). In order to support the development of a recycling society, EU member states are obliged to prepare 50 % of the glass, metal, plastics and paper waste from households for reuse or recycling in 2020 (EU, 2008, article 11). Reuse is not included as a separate target even though it principally is to be prioritized according to the European Waste Framework Directive (EU, 2008). Since the introduction of the 50 % recycling target, the Danish waste management authorities have engaged a process of developing the waste management system to be able to achieve this target.

One of these authorities is the municipally owned waste management company Affaldsselskabet Vendsyssel Vest (AVV) in the Northern Denmark. AVV collects and manages the waste from 46.000 households in two municipalities by collecting the daily discard at the households and by organizing 18 recycling centers. The municipal household waste is almost equally divided between these two disposal routes. Of this waste, 25 % is reused or recycled, and 75 % is material recovered, incinerated or sent to landfill. AVV is thus far from reaching the 50 % reuse and recycling target. The case of AVV is interesting, because the company has a strategic focus on improving their environmental performance. The company's vision is guided by the principles of the waste hierarchy, whereby the overall aim is to direct as much waste to reuse and recycling as possible. Two strategies are introduced to increase both the sorted kerbside collection and the sorting taking place at the recycling centers. The rest of this article is focused on the recycling centers. AVV operates 18 recycling centers where citizen users bring the waste. After a number of initiatives to encourage and enable the site attendants at the recycling centers to improve the quality of the waste sorting, the recycling rates remain low. Too much of the collected waste at the recycling centers are incinerated.

The success or failure of an organization to meet their targets depend on the actual work practices (Brown & Duguid, 1991). Work practices are, however, not always equal to the way the management pictures them to be (Brown & Duguid, 1991); Orr 1990). Hence, initiatives introduced by the management can fall short and not entail the expected results. More importantly, if learning and innovation are to thrive in a company, it needs to be closely linked to the actual work practices rather than to abstract knowledge detached from the practical (Brown & Duguid, 1991).

We therefore investigate the work practices of the site attendants in the company's recycling centers to develop an understanding of how the practices affects the quality of the sorting. We also aim at understanding how the practices are produced, held alive, and how they may be changed in a way that supports the company's vision. Moreover, we investigate how learning and innovation can be situated within

the actual work practices rather than in detached and abstracted imaginations of what goes on at the recycling centers.

8.1.1.1 AVV's strategy, responsibilities and performance

AVV is a municipal waste management company responsible for collecting the waste from the citizens in the two municipalities, Hjørring and Brønderslev. They manage the collection of the daily discard; they run 18 recycling Centers where citizen users can bring their larger waste types; they run a waste incineration plant, two landfills and manage the collection of hazardous waste from industry. The collected waste, which is not incinerated or landfilled, is sold to other actors for further treatment. Moreover, AVV runs a reuse shop where the collected reusable items are sold.

Until recently, the company's identity was formed around the incineration plant (interview with management), but in 2011, AVV got a new manager. With the replacement, a new vision and strategy for the company was developed. This new vision and strategy made a turn towards a greener profile, and put emphasis on finding the environmentally best solutions. The current vision includes ambitious statements like *"eliminate waste"* and *"be 100 % green"* (AVV's internal documents). On a strategic level, the waste hierarchy as a guiding principle inspires AVV and they aim to increase reuse and recycling (management interview). AVV thus aims at being frontrunners within environmental and sustainable waste management in Denmark. They do so by providing educational services to schools, by engaging in collaborations with the environmental department of the regional university, through waste prevention projects, establishment of a reuse shop and a repair workshop, and by participation in different forums for sustainable development of the waste sector. Yet, there seems to be a potential in AVV to sort out more waste for reuse and recycling from the waste currently incinerated.

AVV's innovation department and the management took the initiative to the study; they wondered why the recycling rates at the recycling centers remained low despite their strategic focus on *"moving up the waste hierarchy"*. Different initiatives had been taken such as implementation of new layout and signage at the recycling centers and education of the site attendants on communication with citizen users. This had no effect on the recycling performance. Their assumption was that maybe the understanding of the waste hierarchy had not spread out to all the site attendants yet.

8.1.1.2 Delimitations

Household discard is collected weekly at the households, and most of the daily discard (80 %) in AVV's area is currently incinerated with energy recovery. Bulky waste is to be brought to the recycling centers by the citizen users. Present study

only concerns the waste delivered to the recycling centers. This includes bulky waste and smaller recyclable waste types, such as glass bottles, paper, cardboard and plastics (focus fractions). We define bulky waste as waste, which is too large to be disposed of as daily discard. Garden waste and chemical waste are excluded from the study.

Figure 8.1 shows a map of the largest recycling center at AVV. As observable on figure 8.1, containers for different waste types are dispersed in the area. Citizen users drive in with their car and park the car near the containers for a given waste type.

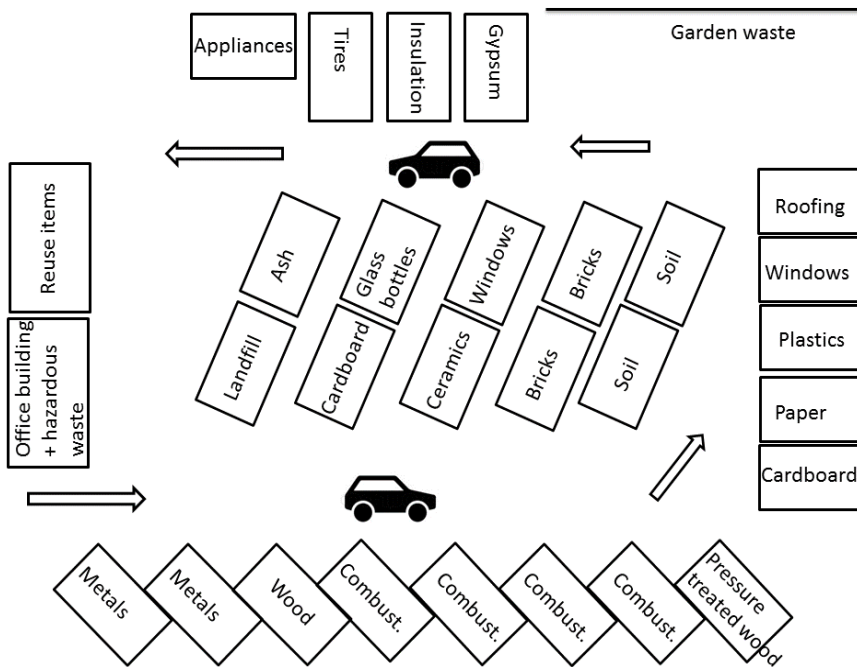


Figure 8.4 Map of the largest of AVVs Recycling Centers.

The recycling center personnel, the site attendants, are present to guide and help visitors to sort their waste correctly. However, for the time being, too much waste is disposed in the container for combustible waste. It is estimated that 50 % of this combustible waste is actually recyclable and could have been sorted out into the recyclable fractions (Larsen et al., 2012). Table 8.1 provides an overview of the focus fractions and how much of each type is currently collected for recycling or incineration at the recycling centers in AVV.

Table 8.8 The types of waste covered by the Danish Resource Strategy and collected separately at the recycling centers at AVV (Hjørring municipality, 2014; and internal documents)

Label	Recycling (tons)	Incineration (tons)	Total (tons)
Daily discard*		23684	23684
Organic waste from daily discard*	155		155
Combustible		18141	18141
Paper incl. Newspaper	3759		3759
Glass (car windows, windows, ...)	714		714
Plastic (garden furniture, hard plastics)	393		393
Cardboard packaging	582		582
Glass packaging (bottles, household glass)	2055		2055
Metal packaging (cans)	40		40
Plastic packaging (plastic film, expanded polystyrene, containers)	66		66
Wood (not pressure treated)	3568		3568
Iron and metal	2494		2494
Bulky waste service collection*		44	44
Total	13826	41869	55695
Percentage	25	75	100%

*Daily discard is collected at the households. A minor part of the organic daily discard is expected to be home composted. This is included in the inventory of the recycling percentage. Moreover, AVV has a small collection service for bulky waste for citizen users who are not able to bring their bulky waste to the recycling centers.

Only 25 % of the focus fractions is sent to recycling. The amounts collected for incineration comprise 32.6 % of the waste in focus. If half of this is sorted out for recycling, the recycling rate would increase to 41 %. Improving the sorting at the recycling centers would thus contribute to achieving the 50 % recycling target (to reach the 50 % recycling it will also be necessary to recycle more of the daily discard, but this study is delimited to only focus on the waste delivered at the recycling centers). In accordance with their strategic focus, AVV also aims at increasing the collection and sales of used products. Currently reuse accounts to 1.33 % of all the incoming waste.

8.1.2. LITERATURE REVIEW

Previous research within waste collection at recycling centers has put the user in the center of the investigation. The user perspective is indeed essential, as it is the users who conduct the actual sorting. If the users do not sort their waste properly, it will affect the performance of the entire waste management system. For this reason, users must be educated (Krook & Eklund, 2010). Reasons for improper sorting can be various. Henriksson, Åkesson, & Ewert (2010) point towards uncertainty among users on how to sort their waste. Products often consist of a mix of materials. Hence, the difficulty lies not as much in finding the containers for a certain waste material, but to understand in which waste fraction the product should be placed (Krook & Eklund, 2010). Improved information, labels and arrangement of the containers have been suggested to improve the sorting (Krook & Eklund, 2010; Woodard, Bench, Harder, & Stantzios, 2004; Curran, Williams, & Heaven, 2007; Eklund et al., 2010; Petersen & Berg, 2004). Help and guidance from staff is essential (I D Williams & Taylor, 2004). Engkvist et al. (2016) write that the sorting quality decreased with a higher number of users visiting the recycling center at the same time. This emphasizes the importance of the help of the site attendants, who can only supervise a few users at the time. Queuing was also mentioned to be a problem by Sundin et al. (2011), because users can get impatient and thus discard their waste where it is most convenient. Increased manning (more site attendants) is often not a solution due to the entailed expenditures (Krook & Eklund, 2010). Moreover, waste sorting is habitual and when habits are challenged uncertainty can arise (Henriksson et al., 2010). The same authors write that for people in general, the environmental consequences seem to be the most important aspect of waste recycling. *“Thus, people need to know that it is the environmental aspects that take priority when waste is ultimately dealt with...[...]. Through meeting this need, [...] the motivation to contribute can be more successfully maintained.”* (Henriksson et al., 2010: 2811). Contrary to other authors, Henriksson et al. (2010) doubts the usefulness of more information, and rather emphasizes the need for motivation.

Due to the urgent call for increased recycling, Danish local waste authorities including AVV have embarked on projects aimed to improve the quality of the waste sorting at the recycling centers (Miljøstyrelsen, 2016). These projects are like

much of the literature concerned on developing solution customized for the users. These include solutions developed on nudging principles such as paint on the ground; rearrangement of the physical aspects of the recycling centers, most notably the rearrangement of the containers; improving signage and labels for the waste fractions to be more intuitive; and test new types of communication with users. Some projects also concern education of the site attendants in recognition of their importance to supervising the users. This education involves knowledge on the down-stream treatment of waste and communication with users. A selection of projects is presented in the table below. They have all received funding from the Danish Environmental Protection Agency.

Table 8.9 Current projects aimed at developing practical solutions to improve the quality of the waste sorting at recycling centers in Denmark (Miljøstyrelsen, 2016)

Waste management company/municipality project	Focus/objectives	Activities	Nature of monitoring methods
Assens Forsyning	Quality of the collected wood	Develop a toolbox and material for educating the site attendants. Develop and test physical initiatives on the recycling center, which enables a better sorting	Quantitative
AVV I/S	Improve the sorting of the recyclable fractions	Develop and test nudging solutions and new physical layout of the recycling centers Increase manning	Quantitative
Billund municipality	Develop a generic model for local recycling centers, designed in accordance with user needs and nudging principles	New layout of recycling centers	Quantitative
Gentofte municipality	Investigate how users can be affected to change behavior	Qualitative analysis of user needs.	Qualitative

	and sort more waste to recycling		
Reno Djurs I/S	Knowledge and competences of site attendants	Develop an educational program for site attendants	Qualitative
Reno Djurs I/S	How to increase collection of recyclable fractions?	Test of: - “waste gate” - Increase of manning - Motivating attendants - Signage - Change setup of containers - Increase information	Quantitative

The success or failure of the tested solutions in the projects is frequently determined by their ability to increase recycling rates. The results are monitored quantitatively by weighing the collected waste. In this regard, present study differs from the majority of the projects as it is a purely qualitative study aiming to *understand* the dynamics of the current practice of the site attendants at the recycling centers before developing and testing solutions. The aim of our study is not to find exact truths and generic solutions, but to provide input to the dialogue and the considerations in the management in AVV, so that decisions can be made on an informed basis.

With this study, our aim is to investigate the role of the site attendants further. Previous studies have already pointed out, that the site attendants play an essential role in educating users in waste sorting. Williams & Taylor (2004) concluded that site attendants actively encourage citizen users to segregate waste at the recycling centers. This conclusion was, however, based on the site attendants own statements (questionnaires and telephone interviews). Thus, we know very little about how site attendants actually work; how they engage with users; which competences they have and need; and which values and logics guide them in their work. Brown and Duguid (1991) and Orr (1996) showed that the way people work in practice not always corresponds to the way they were intended to work. The first step thus is to investigate the actual work practices in more detail. Understanding the actual work practices may reveal reasons for the persistent low recycling rates. The aim is thus to explain the organizational matter of the low recycling rates *in terms of* practices, and seeing this social phenomenon as occurring within the field of practice (or as an aspect or component of the practice), as suggested by Nicolini (2013). *“Practices are fundamental to the production, reproduction and transformation of social and*

organizational matters” (Nicolini, 2013: 14). A prerequisite for improving the practices so that they support more reuse and recycling is to understand what currently constitutes the practices, how they have come to be as they are, how they are sustained, and how they might be changed.

The aim of the study thus is to answer the following question: How do the actual work practices at a recycling centers influence the waste sorting and the reuse and recycling rates, and which elements of the practices should be changed to improve these?”

The aim is thus twofold. The first part aims to examine the actual practices at the recycling centers and link this to the purpose of the work, i.e. the optimization of the waste sorting. By deconstructing the practices, we aim to identify elements that either stand in the way of or encourage a high quality sorting. This deconstruction into sub-components is the basis for the second part to point towards practical solutions.

8.1.3. ANALYTICAL FRAMEWORK

The theoretical outset of the study takes its point of departure in the observations by Brown & Duguid (1991) who concludes that *the ways people work usually differ fundamentally from the ways organizations describe that work in manuals...*. The way people work, i.e. their actual work practices, generate and affect organizational phenomena. This emphasizes the need for scrutiny of the actual work practices when investigating organizational phenomena (Barley & Kunda, 2001). Another overlooked feature in organizations is that learning and innovation are closely linked to the practical activities at work and are generated *within* the communities-of-practice of an organization. Organizational changes and innovation thus cannot be detached from the actual working practices.

But how can we understand practices, and more specifically work practices? First of all, work practices are not equal to work tasks. Practices are broader than that. The work tasks form the ‘block’ or the pattern, which is then filled out by a multitude of unique actions (Shove, Elizabeth; Pantzar Mika; Watson, 2012). Work practices are ensembles, “*sets of actions thematically connected, oriented towards a particular purpose, and framed within a particular object-related activity*” (Gonzalez, Nardi, & Mark, 2009). The practitioners do not necessarily think about the “particular purpose” while practicing, and the “sets of actions” are not just doings, but also “sayings” (Shatzki, 2002), such as common narratives in the organization. Moreover, practices consist “*of shared understandings, norms, meanings, practical consciousness and purposes*” (Shove, Pantzar and Watson, 2012). Emphasis is put on the fact that the practices are *shared* between the actors in the practice-community. As Gherardi puts it, “*Practice is a way of doing things, it is also a way of knowing what to do, it is a way of sensing what is appropriate as well as*

effective” (Gherardi, 2015). The work practices are adopted, learnt and reproduced as the work is carried out in commonly agreed upon ways. This is not so much a conscious process as it is unconscious, and much of the doings and sayings become routinized activities and embodied know-how.

In practice theory, the central unit of the investigation is not the individual (Nicolini & Monteiro, 2016). It is thus neither the site attendants, the citizen users nor the managers of the company whose attitudes and behaviors are perceived to be explanatory to an organizational phenomenon like the low reuse and recycling rates. The individual actors are merely seen as carriers of the practice. When investigating practices, we focus on the empirically observable, i.e. the actions, doings and sayings of the site attendants, but also of the actors in the associated practices, i.e. the management and the citizen users. This is because practices are rarely carried out independently of other practices. They are causally and materially connected to other practices. Other associated practices affect, constrain, conflict, interfere, enable etc. the practices in focus (Nicolini, 2013). Thus they have to be studied relationally.

8.1.3.1 The elements of practice

In order to be able to deconstruct and understand the practices at the recycling centers, we lean on (Shove, Pantzar and Watson, 2012) and their conceptualization of what constitutes and changes practices. They conceptualize practices as something being held together by three elements, *materials*, *meanings* and *competences*. The elements of a practice are presented in figure 8.2. This conceptualization allows us to operationalize the practice idiom. Through the model we can catch some of the dynamics in the practices under consideration and simplify the complex connections between them and their associated practices.

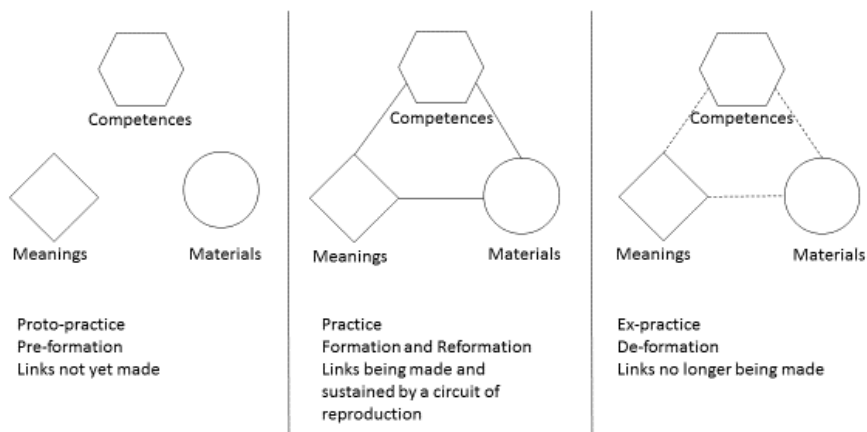


Figure 8.5 Practices are held together by three elements; materials, competences and meanings (Shove, Elizabeth; Pantzar Mika; Watson, 2012). The elements exist on independently before the practice is formed. The practice is formed, produced and reproduced by connecting the elements. Finally, practices can change or dissolve by breaking the links between the elements.

The model can be used to investigate how a practice is created and reproduced, but also how the breaking of the links between the elements of an existing practice can entail innovation in the practice. Here innovation is not understood as product development but as new ways of doing things.

- *Materials* include the waste materials and other things, such as tools and machinery to handle the waste, and infrastructures and technologies like scales and IT systems to monitor the amounts of waste. These objects exist independently of the practice, but compose a vital part of the practice when linked to the other elements.
- *Competences* include different types of knowledge, skills to handle the waste, and know-how and routine in the waste related activities. It also includes explicit rules, principles (e.g. the waste hierarchy) and instructions, but also more practical knowledge.
- *Meanings* include values, images, ideas, understandings, motivational knowledge and aspirations. This element is related to emotional or affective aspects. The meanings-element also includes the shared understandings of what the purposes and motives for the practice are.

The work practice at the recycling centers is made out of a specific configuration of elements. The practice is held alive when the links between the defining elements are renewed over and over through the performance of the practice (Shove, Pantzar and Watson, 2012). This also implies that practices can change when the links between the elements are interrupted. The links between the elements can be broken if an element is removed or substituted by something else (Shove, Pantzar and Watson, 2012: 24). This is where the potential for innovation resides. Innovation does not happen in “a moment of invention”, but in the subsequent stages of adoption and diffusion, for instance when new solutions or new ways of doing something is tested, refined or developed in the on-going participation in the practice (Pantzar & Shove, 2010).

Applying this analytical framework to the practices of the site attendants at the recycling centers, implies an investigation of which elements constitutes their practices. What materials, competences and meanings are currently linked together and how does it transform into observable conduct? Where is the origin of the elements, and how have the links between the elements changed over the years? Additionally, it is useful to investigate the co-evolution, interferences and conflicts of the associated practices of the site attendants (the management in AVV and the citizen users’ practices). Are these practices aligned towards the same purpose, i.e.

increasing the reuse and recycling rates? By elucidating tensions and contradictions and presenting them to the practitioners, we aim to initiate reflections about the practices, which can trigger a learning process within the organization of AVV.

8.1.4. METHODS AND MATERIALS

The research methodology is a case study of the waste management company AVV. The case can be categorized as a critical case. According to Flyvbjerg (2001: 79), the purpose of selecting a critical case is to “*achieve information which permits logical deductions of the type, “if this is (not) valid for this case, then it applies to all (no) cases.”*” Being a proactive frontrunner company, one could assume that the reuse and recycling rates were high in this particular area. This is however not the case, as shown in section 1.1. If a frontrunner company has difficulties achieving the 50 % collection for recycling target, it is likely that other less proactive waste management companies will be challenged too. Nevertheless, this case study is not an attempt to deduce general explanations to the difficulties nor to develop universal solutions to waste management companies. Rather it is an investigation of some possible underlying reasons for the challenges, which may be present in other companies too. The study can thus be an inspiration to other waste management companies in their pursuit to increase their reuse and recycling targets.

In the case study, we have used different data sources in order to increase the validity (Yin, 2009). The data sources and the purposes they serve are presented in table 8.3. Our two central methods are interviews and observations, including participant observation as an apprentice. Additionally, we have scrutinized documents and statistic data from the case company concerning waste collection from the recycling centers and data from the municipal waste plans.

Studying practices, there is a need for both observations and interviews. Practices look different when being observed than they do in post-hoc narratives. This is because practitioners may find it difficult to articulate tacit knowledge, competences and routines that they take for granted (Nicolini & Monteiro, 2016). Observations can provide insight into how the practices are actually performed, whereas interviews can give insight into the practitioners’ meanings, experiences and understandings of the practices (Kvale & Brinkmann, 2015).

8.1.4.1 Interviews

11 out of 27 site attendants and two managers were interviewed. The interviewed site attendants were strategically selected to achieve maximum variation in terms of differences in sizes of the recycling centers (The size and number of citizen users differ greatly among the recycling centers, and especially the number of daily users per site attendant plays a significant role in the site attendants possibilities to ensure a good sorting (Engkvist, 2010)). The interviews and observations were conducted

over a period of two months. They each lasted between 1 ½ and 2 hours. The main interview themes were:

- Formal daily work tasks, daily routines
- Priority of work tasks
 - Goals
 - Feed-back from management
- Knowledge about waste (materials, treatment solutions, environmental and economic aspects)
- Thoughts, meanings, understandings of the company strategy and “*moving up the waste hierarchy*”
- Interaction and communication with users
 - Understandings, meanings and motivations related to the communication with users
- Interaction with colleagues and management
- Suggestions to how to collect more to reuse and recycling/improve the sorting (own reflections)

The interviews were recorded and transcribed. The first step of the interpretation consisted of an analysis of the interviews individually in order to reach an understanding of the individual site attendant and his meanings related to his work practices. Secondly, we used these descriptive analyses to develop a broader interpretation of how the site attendants generally understood their work, including which meanings and competences they articulated in relation to waste and to their work. More specifically, we collected the core themes of the interviews. These include not only the specific work tasks but also the site attendants’ meanings, logics, and values and could thus not have been made beforehand (inspired by Kvale & Brinkmann, 2015). The interpretation process was iterative, as the concepts were developed during the analysis, going back and forth between the interviews and the conceptualization of the practices.

8.1.4.2 Participant observation as-an-apprentice

In addition to the interviews, we observed the practices at the recycling centers by participating as an apprentice (inspired by Wadel, 2015). The participant observation as an apprentice implies that the researcher enter into the working relationship with the site attendant, wearing the same clothes, performing the same tasks, following the same working routines and meanwhile observing the site attendant in order to get socialized into the work practices in the organization (Wadel, 2015). This method provides the researcher with a firsthand experience of adopting the workers’ practices. This socialization process is a reflexive process, in which the sub-elements of the practices become more evident than if the researcher had observed the workers from the sideline.

During the observation, the researcher recorded notes and reflections based on the observations. Additionally, the researcher made small notes. The challenge was that making notes interrupted the apprentice role. Yet, notes are necessary as data material for later interpretation. We found it more effective to have a recorder in the pocket, which could discretely be picked up for recording the observations as they happened. When the workday ended, we made thorough notes immediately after we had left.

In addition to the participant observations at the recycling centers, observations were also made at the site attendants' quarterly meetings with their manager, and at two employee meetings with all the employees in the company. Notes from these meetings are a part of the data material in this study.

Table 8.10 Data sources and their contribution to the study

Method	Purpose/aim
Observations - At the recycling centers - Meetings in the company	Observe how the practices unfold ad-hoc Identify common "sayings and doings" Observe how the practices are debated among the practitioners Uncover connections to associated practices, and how these connections affect the site attendants practices
11 interviews with site attendants	Acquire insight into the site attendants' thoughts and understandings (meanings) about their work practices. Collect common post-hoc narratives Identify common dominating meanings
2 interviews with managers	Acquire insight into the managers' thoughts and perceptions of the company strategy and on the practices at the recycling centers
Company documents	Acquire insight into the company's vision, strategy and waste plan. Acquire quantitative documentation of the reuse and recycling results (the results of the current practice)
Literature review	Investigate previous research on how to increase the collection of waste for reuse and recycling on recycling centers Investigate how the practice approach has previously been applied to studies of waste related behavior

Case studies, and particularly the ones which rely on qualitative data, are frequently accused for being biased towards verification (Flyvbjerg, 2001). Indeed, the qualitative methods allow the researcher more room for interpretation than quantitative methods do. However, there is rarely a single causal factor for an organizational phenomenon to be discovered. Analyzing and presenting the complexities of the organizational phenomena is thus of more value than simplified explanations. As we included a variety of different types of data sources, we were able to combine ideas and evidence in different ways, thereby increasing the validity of the research results. Most importantly though, the validity of the study was increased when we presented our analysis to the site attendants and to the management at AVV. This gave them the opportunity to comment on our findings and correct misunderstandings.

8.1.5. PRACTICES AT THE RECYCLING CENTERS

8.1.5.1 Historic development of the practice

Before analyzing the constituent parts of the site attendants' practice, we take a look at the historic development of the recycling centers. The history of the practice can provide some understanding of the pre-existing elements of the practice and how they relate to the current challenges with the sorting quality.

20 years ago, the recycling centers were called nicknames as “*the Dump site*” (*Da: losseren*) or “*the Incineration*” (*Da: forbrændingen*). The name of the site stemmed from the dominant waste management solutions then. Users could dump their waste without any prior sorting, and it was quick and easy for the users to get rid of the waste. At that time, AVV took great pride in being a good service provider (interview with manager). The manager emphasized that it should be a good experience for the citizen users to visit the recycling centers; they should be able to easily get rid of their waste, for instance, not having to queue. Applying this to our model, being a service provider was one of carrying *meanings* for the management. Another element holding the former waste practice together was that the waste materials were to be feed into the incineration plant for energy to be recovered. Energy recovery was perceived to be one of the most sustainable solutions to the waste problem, and indeed it was preferable to landfilling. The site attendants' main function was to be warden keeping order on the site and helping people dump their waste easily. The title *Site attendant* appropriately describes the work function then.

As the call for resource efficiency increased, more waste fractions for recycling were gradually introduced. The introduction of more waste fractions for recycling is a change in the material element of the practice. It is also a change in the formal rules and instructions (included in the competence element). This introduction of new elements interrupted some of the links between the elements of the existing practice. More specifically, it the site attendants and the citizen users needed to acquire new

competences to sort the waste correctly. In order to acquire new competences, the site attendants received formal training. This training included knowledge on waste materials and insight into downstream treatment solutions. As their job function changed from mainly being a warden to becoming a guide who is to teach the users to sort their waste correctly, they also received formal training in communication techniques.

The historic development illustrates that discarding waste at the recycling centers is not a new practice, but an existing practice which needs to be changed. Some of the elements have changed over the years, but other elements may have remained. The history also elucidates how the site attendants' practices are interlinked with the practices of the management and the practices of the users. Figure 8.3 illustrates this.

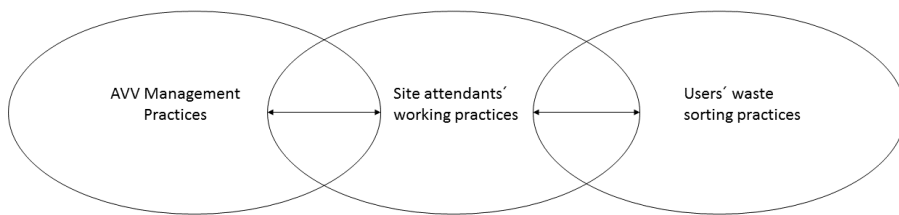


Figure 8.6 The site attendants' practices are associated on the one side with the practices of the management, and on the other side, the practice of the users. The site attendants' practices are thus relational and the link between the management and its users.

The management responds to changing conditions, such as the 50 % recycling target. To achieve the target, the citizen users need to sort the waste better. Unlike previously, the site attendants' work today has more to do with educating citizen users in correct sorting. As the manager puts it, the site attendants are “AVVs *public image*”. It is within this context, that the further analysis of the site attendants' practice should be understood.

8.1.5.2 Waste sorting at the recycling centers: Materials, Competences and meanings

The first element, the *material object*, is the waste discarded by the users. This waste consists of different materials, and the waste products can be composed of more than one material. For instance, much furniture consists of several materials such as wood, textiles, metal and glass. This mix of materials means that it is not always obvious in which container to discard the waste product (Krook & Eklund, 2010). Correct sorting of the waste thus requires *competences*. The *material objects* are also the containers and the layout of at the recycling centers. The site attendants have the authority to decide how the containers should be organized. Many considerations lay

behind the current layout: it should be easy for the users to throw in the garbage; there should be space enough for cars with trailers to drive in between the containers; the transporters should be able to empty and replace containers; safety must be prioritized; and so on. As an example, the container for cardboard are placed next to the container for combustible waste at most of the recycling centers. This is due to the site attendants' practical experience that users find it inconvenient to walk far with their cardboard. The final layout is thus not random, but a direct consequence of the other element, the *competences* acquired in the on-going performative work practice. The way the site attendants have used their *competences* to change the organization of the *material objects* with the aim of affecting the users' waste sorting practices shows how learning and innovation is closely linked to the actual practice. Nonetheless, the change in the material elements has not been sufficient to change the users' sorting practices towards higher reuse and recycling rates.

Competence has to do with skills and knowledge. The site attendants have knowledge about waste products, waste materials, and waste treatment solutions. This knowledge is partly acquired through the formal training, and partly through the practical experiences with the work. Another type of competence is the skills related to the interaction with users. *"With experience, you learn to spot them, just like a customs officer; you learn to see who needs help and who does not"* (interviewed site attendants). Although the site attendants have received formal training in communication, the skills to use this knowledge are developed by attending the practice. It is within the performative practice that the learning takes place and the ways of engaging with users is developed. Here they can experiment with ways to address users when they sort wrongly, and ways to encourage them to sort correctly. The purpose is not only to teach the users about the sorting practice, but to help them become practitioners. This learning is not so much about acquiring explicit formal expert knowledge, but more about an embodied ability to behave as community members. Hence, the importance is how the site attendants manage to incorporate the users into the practice. The only formal work instructions at AVV concerning user interaction is: *"The site attendant should guide and advice the users on correct sorting of waste in a nice and polite manner"* (citation from work instructions). In practice, the encounters with users are diverse, and most of the site attendants admit that being nice and polite is not always easy. Observations of the site attendants at work show that they tend to give short, neutral/polite instructions to the users. Their post hoc descriptions, however, emphasize the use of different types of arguments to incite users to sort their waste. Additionally, the multitude of narratives about conflicts gives the impression that conflicts occur frequently. However, no conflicts and no longer argumentations on why to sort the waste occurred during the observations. Meeting users in a nice and polite way is a pre-existing practice connected to all kinds of service jobs. The average citizen user visits one of AVVs recycling centers once a month. At these visits, the users are to adopt waste sorting competences from the site attendants, and the site attendants

need additional competences to incorporate the users into the practice. The question is, if an addition of competences to the users' practices will result in higher reuse and recycling rates, or if the motivational meanings of the practice also need to be replaced to achieve the desired results.

The third element, *meanings*, is related to emotional understandings and values. According to Shove, Pantzar and Watson (2012), the elements of a given practice are pre-existing, waiting to be linked to other elements. As our analysis will show, this element is more complex than the former two, and the *meanings* may also be the determining factor for the troubles with the sorting quality. What meanings the site attendants have linked to the other elements are not as directly observable as the other two elements. Thus the interviews provided insight into this element. As it would be too lengthy to give a full account of the meanings involved, the following section provides three examples where the site attendants' understandings, logics and values (*meanings*) affect the result of the work practice negatively. These three examples were chosen due to their impact on the collection for reuse and recycling.

The site attendants' image of the users

An observable part of the practice was that often reusable things in good shape were discarded in the container for combustibles, without the site attendants doing anything to stop it. The interviews revealed some common sayings among the site attendants about the users' attitudes towards direct reuse; Users would not like to see their old stuff appear in their neighbor's home; and users could especially hold sentimental values to stuff previously owned by dead relatives; and users want the waste sorting to be as easy and convenient as possible. The latter seems to be a pre-existing meaning from the previous configuration of the practice. These understandings had the effect on the performative practice that the site attendants were reluctant to ask users to put reusable things aside for reuse rather than discarding them for waste treatment. Similarly, some of the site attendants refused to pick up reusable things from the containers for fear that they might offend the users. Boots, jars, drying racks, books, picture frames, chairs etc. are thus discarded even though they could have been collected for reuse. This was despite the fact that the management recently changed the formal work instructions (included in the *competence* element) to increase the collection for reuse. When asked, the site attendants said they knew which type of things held reuse value and they knew that the management wished to prioritize direct reuse. Despite their knowledge, they did not act upon it. This indicates that the meanings and understanding, whether they are bad excuses or urban myths, have a strong influence on the performative practice, and that changing rules or increasing information is not sufficient to change the practice.

"Nice and clean"

In the interviews, all the site attendants talked about keeping the recycling center nice and clean, and avoid wrongly sorted waste in the containers for recyclables. "I

am quite pernickety [about the cleaning]. I want it to look nice and clean". This site attendant elaborates why he appreciates order and cleanliness; if the recycling center looks nice and clean when the users arrive, they are more likely to leave it in this same condition. This understanding he shares with the other attendants, who all emphasize the importance of keeping the center clean by sweeping, cleaning and mowing. Cleaning, sweeping and mowing are work tasks which are emphasized in the work manual. These tasks constituted the main job function in the times when the site attendant job was to be a warden. The old meanings thus linger. In addition, when the manager visits the recycling centers he often comments upon the appearance of the center. Mostly he acknowledges the attendants for the centers nice appearance. The manager is thus contributing to reproducing the practice by strengthening the meaning/importance of cleaning.

The cleanliness rationale also applies to wrongly sorted waste. The more wrongly sorted waste is put into a container, the more it will attract from the users. This could for instance be glass put into the container for ceramics, wood or cardboard and plastic in the container for combustible, quarry tiles in the container for broken bricks (according to the site attendant interviews). The site attendants have a shared understanding that the users observe what is already inside the container and reproduce the sorting. By keeping the center and the containers clean, the site attendants reproduce and introduce this practice to the users without explicitly telling them what to do. Most of the users unconsciously learn these sorting skills and absorb the practice. This is an example of how competences are passed on to the users through the performance of the practice.

Cost-optimization

The interviews with the site attendants revealed a recurring feature, which was not expected during the preparation of the interviews: all the site attendants and their manager, talked a lot about the financial aspects of waste management and of running the recycling centers. *"I am thinking economy all the time. Some of the containers are expensive to get rid of, so we mustn't fill those more than necessary. I try to make it as cheap as possible"*. Here the site attendant tells how he continuously seeks to optimize the operation economically. Even though economy is important, it is not the site attendants' formal job function to ensure a financially viable operation. Economic optimization is also not included in the work manuals. Nevertheless, the attendants share an understanding that economic optimization is of prime importance. When asked, they do not perceive environmental perspectives to be similarly important. *"It is alright that we have to reuse and recycle more of the waste, but it will be more expensive for the company"* (site attendant). Another of the attendants expressed his difficulties accepting that recycling could be costly: *"It's the whole system that's wrong. The most expensive solution should be to landfill it, but in some cases, for instance ceramics and insulation, it is costlier to recycle it. I think that is wrong. But I'll toe the line, even though I think it's crazy. I guess I have to."* This site attendant expresses frustration about the contradiction

between environmental and economic optimization. The fact that he is asked to perform his work in a way that does not correspond with his financial logics seems to be hard for him to accept. This illustrates how central the economic optimization is in the shared meaning of what is important in running a recycling center. This understanding guides them in their daily work. The site attendants' concerns about the economy may prevent them from optimizing recycling of the waste fractions that are not financially viable.

The strong emphasis on economy also affects the site attendants' dialogue with the users. They expect that the users value economic optimization too. Being a municipally driven company, the recycling centers are publicly funded. In other words, it is the users' money being spent on the more expensive solutions. The site attendants have to vouch for the spending in the meeting with the users. Hence, they use economic arguments when trying to convince users to sort their waste correctly: *"People must be able to see the logic and the economy in it [in sorting for reuse and recycling]. If you can explain to them that there's money in it, it is much easier to make them do something... If you can tell them, that AVV saves this or this amount of money, and thus save themselves from the taxes, then you can incite them to sort [their waste]"*. This may be the reason why they are more eager to tell the users about the income from the separate collection of cardboard than the expenditures on recycling of for instance ceramics or plastics.

The idea that people are more willing to sort their waste if they are told, that AVV can sell the recyclable fractions is dominant among the site attendants. They unanimously agree that economic arguments are useful to encourage citizen users to sort their waste at the recycling centers. The site attendants were asked, if they used environmental or resource related arguments to the users. Some do, but they all insist that economic arguments are more useful, whereas environmental arguments only interest a few users. This is in opposition to the study conducted by Henriksson et al. (2010), who found that the environmental concerns were the dominant driver for engaging users.

The economic value is also a pre-existing element, which have been connected with the other elements to form the current practice. Where this pre-existing element stems from may differ from attendant to attendant. Some of the site attendants have previously had their own business, and they say that they are *"used to thinking about cost-optimization"*. Yet, they sustain this value through their discussions with each other and with the users and link the economic rationales to the waste sorting.

Another reproduction of the economic rationales happens in the association with the managements practices. Narrations about economic perspectives often occur when the management engages with the site attendants. An observed example: At the quarterly employee meetings, the manager of the recycling centers informs the site attendants about the economic perspectives of their work. Feed-back from the

manager frequently concerns economic perspectives. For instance, he argues that containers for recyclables are expensive to sell if there are too many impurities. He moreover provides them with information on the prices of the waste materials, but not with information about environmental perspectives of the materials, for instance their toxicity or how they could contribute to resource conservation. Another example of how the top-management contributes to reproducing the practice occurred at an employee meeting for the entire company. Here the CEO praised the recycling centers for their economic performance. The fine results were attributed to the actions of each of the employees. The site attendants were applauded by all the other employees in the company. The appraisal for the economic performance was not followed by any information about the environmental performance. These episodes show how the company management contributes to reproducing the strong focus on economic performance over environmental, hence nurturing the pre-existing meanings and keeping the current practice alive.

8.1.6. DISCUSSION

The analysis shows that the constituent meanings in the practice not all support the objective of collecting more waste to reuse and recycling. This adds to previous research, which emphasizes the need for changes in the material setup of the recycling centers. Changing the material and competence elements has not been sufficient to increase the collection rates. The site attendants do not seem to find increased reuse and recycling particularly important. To them it is more important that the economy is optimized; that the recycling centers look nice; and that they do not disturb the users more than necessary with requirements to their sorting. What characterizes these meanings is, that they hold internally conflicting elements. Optimizing the environmental performance in some cases conflicts with optimizing the economic. Correcting users can conflict with the feeling of providing a good service. This conflict was also found by Engkvist et al. (2016). The time for sweeping and cleaning may conflict with the time for engaging with users. It is important that managers understand these inner conflicts in the practice in order to be aware of how they themselves contribute to sustaining or changing certain elements of the practice. The management currently plays a significant role in sustaining undesired patterns of the practice. What they emphasize to be important, i.e. what they provide feed-back on, is adopted by the site attendants as a part of their practice. This shows that what really affects the working practices are not changes in the visions and strategies at management level but the character of the interaction between the management and the site attendants. Following this argument, our recommendation to the management is to provide feedback on what they actually seek to achieve, i.e. increased collection for reuse and recycling. This could include the setting of specific targets for the individual recycling center including a continuous evaluation of the performance. Setting specific goals has proven to be effective in improving results in organizations (Latham, 2003). By doing so, the meetings between the site attendants and the managers would be more

concerned about the achievement of a common goal, a common meaning. Additionally, new narratives in the organization could be developed or pre-existing ones enhanced to substitute old ones. This includes the enhancement of a shared understanding of a having a common purpose, which is no longer structured around the incineration but around the reuse and recycling. Additionally, new narratives to supplement the economic focus are needed. Leaning on Henriksson et al. (2010), who pointed out environmental concerns as a dominant meaning among users, articulation of environmental values within the organization could form new links to the existing practice.

Substituting old meanings with new ones could spark learning and innovation at the recycling centers. If the dominant aim of the site attendants becomes increased reuse and recycling, they would modify their actions and daily performances of practice to reach their targets. How exactly the site attendants are to hand over the practice of good sorting to the users is a matter of learning and innovation. The other requisite ingredients for innovation are already there; the material infrastructure currently supports the objective, the site attendants have knowledge on waste sorting and treatment solutions, and they have competences in the form of education on communication. What lack are the final motivational meanings. The challenge is to evoke new meanings and to make creative associations between the other ingredients in the practice.

The symbolic meaning of the name “site attendant” refers back to the previous role as a warden attending the site. Changing the name of the site attendants to something that reflects their role as supervisors with a mission to handle waste sustainably might challenge the attendants’ understanding of themselves and their role at the recycling centers. Moreover, a new title might affect how the citizen users perceive the attendants.

Innovation can be the invention of a new solution, for instance changes in signage and layout as emphasized in previous research (most notably Sundin et al. (2011)). But innovation also happens in the on-going process, where the site attendants uptake and experiment with the implementation of new material solutions or communicative techniques in the interaction with the users. A site attendant who finds reuse and recycling meaningful and worth pursuing, will strive to find solutions and ways to engage the users. Solutions are developed in a reflexive process occurring within the dynamic relationship between the site attendants’ practices and the users’. Learning for instance in the form of developing new communicative competences, can only occur in the meeting with users, i.e. by attending the practice and repeating, reproducing and reinventing certain actions of the practice. Before these learning processes can take place, linking new meanings to the other elements of the practice is needed. New meanings are to substitute the dominating meanings of the old configuration of the practice. If motivating meanings are not a constituent part of the site attendants practice, it is questionable

that any reflexive learning processes regarding the integration of users into good sorting practice will take place. A successful integration of the users requires an adaptation of meanings and values to make the waste sorting meaningful. This is an overlooked point in contemporary recycling center projects in Denmark, including in AVV's own recycling center project. These projects rely on top-down processes, where the management develops and decides which initiatives are to be taken. The initiatives in most of the projects concerns material elements like layout and information, and competence elements like education of site attendants. Rarely deliberate attempts to affect the underlying meanings of site attendants and users are made. And rarely the innovation potential in bottom-up approaches is realized, whereby the site attendants are not included in the process. Thereby the learning and innovation that could have taken place is not harvested.

8.1.7. CONCLUSION

The formal aim of the working practices at the recycling centers is to achieve a better sorting of the waste. More specifically, there is a government set objective to increase the recycling rate to 50 %, and it is an important part of AVVs strategy to increase the collection for reuse. The current elements of the site attendants practices at the recycling centers do not support this aim. Especially, motivating meanings lack. So far, AVV has changed the material elements at the recycling centers by continuously adding more fractions for recycling. Additionally, there has been a focus on improving the competences of the site attendants through formal training. Changing the material and competence elements of the practice has changed the practices of the site attendants, but not sufficiently to achieve a significant increase in recycling. In order for the practice to support this goal, it has to be meaningful to the site attendants. The question remains how to create new meanings. Our suggestion is to transfer the 50 % target to the individual recycling center, and follow up with continuous feed-back. The dominating feed-back from the management has so far concerned the appearance of the center and economic aspects. This feed-back from management has been a vital element in keeping the practice alive, but has not supported the goals in the company strategy nor the government set targets. This shows that the dynamics of the association between the management's practices and the site attendants' are more important for the site attendants than the company's visions and strategies are. The site attendants actually do what the management signals to be important. Hence, it is likely that introducing new specific targets followed up by feed-back could stimulate the site attendants reflections on why and how they perform their job. It could incite them to investigate new ways to supervise the users.

All member states of the EU face the challenge of increasing the collection for reuse and recycling to achieve the 50 % target. Though the outliers of the individual countries differ greatly, a common feature in many cases is that there will be site attendants engaging with citizen users at collection sites. This study shows that the

practices of the site attendants (and maybe also the users) contain elements which stems from previous configurations of practices build up to serve other infrastructural systems, in this case incineration. Links to these old elements need to be broken. Our study also points towards the importance of understanding the practices of the site attendants, and how these practices can be affected to support the pursuit of higher reuse and recycling rates. A general recommendation is that the management of waste authorities should not only rely on abstract knowledge, but also understand the actual work practices when seeking to create learning and develop solutions. Moreover, managers should be aware of their own contribution to reproducing inexpedient practices. Rather they need to transfer their own goals to the site attendants, set specific targets and provide useful feed-back. Specific targets can be a motivating driver initiating a reflexive process among the site attendants on the usefulness of different performances of their practice.

We have come a long way since 100 % landfill, but there is still a great potential. Users have changed their practices before, so there is no reason to believe that they cannot do it again. For the users to improve the sorting of waste, the working practices of motivated and skilled waste supervisors are key. It is within the actual work practices that the key to change lies.

CHAPTER 9. DISCUSSION

The outset of the present PhD project was to investigate the role of a municipal waste management company in a transition towards a circular economy. I have used a qualitative, single case study as inquiry strategy. This has had an impact on how I developed and used the conceptual framework, and what results I have been able to attain. The evidence I have presented throughout the thesis consists of a joining of literature reviews, interviews, and collection of data from AVV. Besides much of the understanding is obtained from the ethnographic field study, observations and participation in the daily work in AVV and are thus also a result of an interpretive process. In this chapter, I discuss the findings on a more general level, and try to extract learnings from the AVV case to a broader understanding of the role of municipal waste management in circular economy. This is in order for the project to inform other actors than AVV and share a greater understanding of both the current *outset for the transition* towards a circular economy and the more general learnings about *what can support the transition* towards a circular economy.

9.1.1. IS DANISH WASTE MANAGEMENT IN A LOCK-IN?

The European circular economy package put waste management authorities in the frontline of the development of more circular solutions to replace the predominant waste treatment solution in Denmark, i.e. incineration, but some scholars argue that waste management is locked-in to incineration (Corvellec, Campos, & Zapata, 2013) and that this impedes the development of solutions further up the waste hierarchy.

The waste management sector has been assessed to be locked in to incineration, and this lock-in is assessed to remove incentives to innovation for the upper layers of the waste hierarchy. Yet, AVV seems to be an example of a waste management company, who is not that much constrained by the incineration plant. Indeed AVV has overcapacity in the incineration plant and they even import waste from other municipalities, England and Norway to meet this capacity, but at the same time they experiment with initiatives and solutions for waste prevention, reuse and refurbishment. Even though the predominant waste treatment solution for many years has been incineration, AVV has always worked with the upper levels of the waste hierarchy:

- The reuse shop has existed for 30 years,
- Encouragements to prevent waste was sent out to citizens as part of the information material
- Voluntary and proactive initiatives to develop better solutions for WEEE collection and treatment took place in the 1990's and early 2000s,

- Experiments like “117 reasons”, “experiences with waste”, and Nulskrald focused on engaging citizens in waste sorting and prevention
- In GodtGjort values are created from waste through refurbishment of post-consumer products in collaboration with other actors

Most of these initiatives and projects took place before the circular economy concept emerged on the agenda in Denmark and at AVV. As described in chapter 4 and 7, the waste hierarchy was previously also not applied in a conscious and systematic way by AVV. Nevertheless, there were at AVV some values and a genuine interest in doing something proactive to improve the environmental performance of the waste management and a recognition that this required innovation and an engagement of the citizens.

Does this mean that an investment in an incineration plant does not inevitably lead to a lock-in and impede initiatives to move up the hierarchy? The import of waste for incineration gives AVV the possibility to experiment with prevention and preparation-for-reuse of the municipalities’ own waste without too much jeopardy. The investments in the incineration plant can be satisfied, and the capacity can be utilized for the next decade, after which it is expected to become obsolete. Meanwhile new solutions further up the hierarchy can be developed in a fairly protected environment where it is ok to fail, since there are no larger economic consequences of them anyway. As long as AVV does not depend on the development of new solutions for survival, there is still room to fail and thus courage to test and experiment with creative ideas.

9.1.2. DRIVERS FOR INNOVATION AND EXPERIMENTATION IN AVV

What has then been the drivers and the motivating factors for innovation and experimentations with moving up the waste hierarchy?

Concerning this question, AVV might be a deviant or an extreme case in comparison to the average municipal waste management company in Denmark. As pointed out already in chapter 2, some people working in AVV hold personal and professional aspirations, competences, skills and values that may be more determining for what happens in AVV than any external structures or forces. The forces that pull in another direction in AVV are more related to the organizational culture and the people employed: The innovation manager, who encourages experimentations and outreach for collaborations with new types of stakeholders. The board chairman, who appreciates the creation of new jobs. The CEO who is personally concerned with the “resource crisis” and is eager to develop and manage *the best* waste management company. Several employees with a sincere interest in sustainability. A culture in the company that fosters innovation, playfulness and outlook. Values in the company (chapter 4 and 7.2) that focus on sustainability and affecting the societal agenda. The presence of these factors shows that investments in

infrastructure does not entail a lock-in per se, if other forces pull in another direction.

Nevertheless, the experiments with “moving up the waste hierarchy” have revealed a number of other barriers to the transition towards a circular economy, which applies to all municipal waste management companies regardless of their internal culture or interest in innovation. Recent regulatory requirement to increase recycling has pushed municipalities in Denmark to develop and implement solutions that deviate waste management away from incineration towards one step further up the waste hierarchy, i.e. recycling. These legal requirements are the first real push to un-lock the waste management regime from its linkages to incineration, but other barriers have become evident through the innovation processes that AVV has been through. They will be described in the following.

9.1.3. BARRIERS FOR PREVENTION, REUSE AND REFURBISHMENT

Reuse and recycling depend on the trust of the citizens and the willingness and ability of the citizens to sort their waste. This challenge is the least of the challenges. Citizens are generally willing to sort their waste, but their willingness depend on a trust in the system. For instance, as found in Article D, some citizens think that some separately collected waste is burnt anyway. If such perceptions come to dominate, the citizens might not be willing to sort their waste well. They need some assurance that their effort actually brings about reuse and recycling and benefits to the environment and society as such.

9.1.3.1 Market barriers

Yet, the municipalities cannot always provide such transparency and assurance that the separately collected waste is actually recycled. For instance, as found in Article C, waste wood is difficult to sell on the market. The total national collection of waste wood (=the supply of waste wood) exceeds the demand for waste wood from companies, such as NovoPan who uses it to produce chipboards. For other waste materials, it is difficult for waste management companies like AVV to track what happens to them after they are sold to the broker (this could be a subject for further research). This is for instance the case with plastics (Article C). Both waste wood and separately collected plastics may end in an incineration plant due to lack of technological and market capacity to absorb them. If consumers learn about this, it might reduce their willingness to sort their waste. This shows the interdependency between social and technological elements in the system.

Given the fact that all EU member states are obliged to collect 50 % of the household waste for recycling by 2020, there is reason to fear that the market for secondary raw materials will be negatively affected: The supply of waste materials might come to exceed the capacity to recycle it, thus making it increasingly difficult

or costly for municipal waste management companies and authorities to market the collected recyclable waste. On the other hand, potential investors will need certainty of a steady supply of waste in order to invest in development of recycling technologies, and the collection targets thus might contribute to encourage investments in recycling technology. Yet, there may be a transition period in which municipalities will struggle to market their recyclable waste.

In the experiment described in Article C, AVV managed to increase the collection of reusable items from the recycling centers significantly. In fact, post-consumer products for reuse was the waste fraction that was most significantly increased, and the volumes of reusable items exceeded the volumes of other waste fractions such as cardboard and plastics. However, we also witnessed a decrease in the quality: the more waste collected for reuse, the more also had to be discarded afterwards, because it could not be sold in the reuse shop. This indicates a limit to how much reuse can come to account for in the total share among waste treatment solutions. Besides, the reuse organized by municipal waste management authorities is the last possible life prolonging use cycle before material and energy recovery, i.e. the reuse potential of post-consumer products collected at recycling centers is lower than second-hand products sold for instance on eBay.

9.1.3.2 Institutional barriers and need for political visions and support

There is a lack of technological capacity in Denmark for recycling waste materials (much waste is treated abroad). As pointed out by AVVs CEO, the political announcements about a potential further liberalization of the waste sector makes the municipal waste authorities reluctant to invest in reuse and recycling solutions.

Similarly, the political debates about the legality of the reuse shops and prepare-for-reuse activities in the municipalities, fueled by the complaints from the Confederation of Danish Industry (Dansk Industri, 2015) might reduce the willingness of municipalities to develop reuse shops and prepare for reuse-activities. AVV is an exception from this. AVVs practical full-scale experiments have shown that it is possible to operate a reuse shop in a viable way with additional social affects, thus achieving a triple-bottom line. Likewise, the GodtGjort workshop experiments are becoming real-life examples of what can be achieved within the municipal waste management if other performance indicators than a limited cost-effectiveness are pursued. Yet, for the further dissemination of such preventive and loop slowing solutions there is a need for political support for the municipalities to do this. Ambiguity of the legal guidelines was also found to be a hindrance of the WEEE refurbishment (Article B), and it is fair to assume that clarity within the legal framework is also needed within prepare-for-reuse of other product groups than WEEE. Other European member states, such as Belgium (Flanders and Wallonia) and Spain, have set specific prepare-for-reuse targets (2 %) for certain WEEE

product groups (Rreuse, 2017). Such legal requirements can help push the development of prepare-for-reuse activities.

Currently, municipal waste management companies and authorities in Denmark are not even allowed to finance waste prevention activities by the citizen fees (cf. the consultation response for the prevention strategy (Miljøstyrelsen, 2015)) (Miljøministeriet, 2012). This is an institutional constraint for waste management companies to make waste prevention initiatives. A suggestion could be to earmark a certain percentage of the citizen fees to waste prevention initiatives.

Regarding regulation, the fact that the requirements to waste management only comprise “collection for recycling” and not actual recycling can become a hinder for the circular economy. Some organizations are pushing for higher collection for recycling targets and problematize that 50 % is not high enough. Given the risk that the demand and the technological capacity for recycling and closing the material loops are not yet in place, it could be argued that rather than strengthening collection target, measures to ensure that actual recycling and reentrance of the secondary raw materials into production should be taken that is underway as part of the EU eco-design directive and the Circular economy package. For further enabling of closing the material loops, requirements to industry regarding recyclability of the materials in products should also be taken. Otherwise there is also a risk that harmful substances in products will be brought into new products in the recycling process, and the steps taken with the ROHS and REACH directive are important but need to be advanced further.

9.1.3.3 Socio-cultural factors

Prevention is a somewhat delicate theme as it is related to consumption and thus to political visions of growth. It could be somewhat controversial if a public waste management company encouraged a reduction of consumption and thereby counteracted the political strategies of economic growth. However, as Article A shows the greatest waste prevention potentials that can be achieved through changes in consumer behavior alone are in paper waste and food waste, and preventing these waste types does not collide with general consumption. Prevention of these two waste types can be addressed and encouraged by waste management authorities and companies in campaigns and through citizen awareness and engagement programs. Preventive measures can also be taken by other actors further up the value chain, but as Article A also found these are more difficult to approach by a waste management company. The municipal waste management company already have a relationship with the local citizens, but not with global producers and designers. Nevertheless, possibilities for waste management companies to engage in collaboration with industry actors about designing for avoidance of waste could be a theme for future studies. The most notable preventive role a waste management company can play is to encourage the local citizens to change waste generating behaviors through

communicative and awareness-creating programs. Moreover, they can enable reuse, for instance by operating a reuse shop as AVV does.

9.1.4. BUSINESS LOGICS OF WASTE MANAGEMENT

From a purely business economic perspective, AVV has much higher costs than revenues from collection and sales of recyclable waste as shown in Article C. There is thus no business economic incentive to improve recycling apart from the incineration and landfill taxes. Yet, the reuse shop balances, and this illustrates that reuse as a waste management solution can be operated in viable terms.

The difficulty of measuring the effects of for instance a campaign for waste prevention may be a hindrance for the further dissemination of waste preventive measures, as shown in Article A. How much will a waste management company be willing to invest in waste prevention, when the evidence of the effects of a particular prevention campaign are difficult to account for? For this reason, there is a need to develop assessment methods and tools for waste management companies to work with prevention and not least creation of incentive structures that push them to engage in waste prevention activities despite the lack of clear documentation of its effects.

9.1.5. WASTE PREVENTION AND THE NEW NARRATIVE

Waste as a resource is an underlying view in the circular economy concept, and it directs attention towards how value can be extracted and created from waste. This value creation logic is new to municipal waste management companies, who have traditionally aimed more for cost-efficient management of waste handling. AVV has attempted to ride on the wave of this societal narrative, and they have also contributed to strengthening and disseminating this narrative among citizens, in the waste sector and within issue arenas concerning circular economy. AVV has through full scale experiments such as Nulskrald and Godt gjort been able to create and strengthen this narrative and has got a lot of positive attention in this regard both locally and nationally at conferences within the waste sector. The communicative and awareness creating effects of their business activities may actually be AVV's main contribution to the transition to a circular economy, and the importance of this should not be underestimated.

The emergence of the circular economy concept can thus be seen as a further support for these initiatives, and a way to rethink the prevention and reuse activities and consider the waste hierarchy in a more reflected way. The circular economy concept have contributed with new ideas about making products from waste and collaborating with new types of partners. Mainly, it has placed a more distinctive emphasis on the value of the inner circles (preparation for reuse) and thus

contributed to making evident how the waste hierarchy can be prioritized in practice and integrated into the legal framework for waste management.

9.1.6. CONSIDERATIONS REGARDING THE USE OF THE BUSINESS MODEL CANVAS

Using the business model canvas as an analytical tool has helped visualize the connectedness between the different value propositions in AVV and the interconnectedness of these and other elements in the business. A disadvantage of the business model perspective is that it limits the focus to the individual company. The circular economy concept sets the stage for changes at system level, and the practical experiences from the development of Godt gjort and the WEEE refurbishment shows that this type of circular solutions are enabled through co-creation of value with other actors. The business model concept may not fully capture this aspect, because the assessment of the value creation in a triple-bottom line perspective needs to be made from a system/societal perspective rather than the individual business perspective. As an example, the environmental impacts of the business collaboration with Plyssky must include considerations of what it replaces. The social effects should include the personal advantages for the people employed in AVV and the consumers buying the products. The economic bottom line should include not just AVVs cost and benefits, but also Plyssky's, and the local municipality's due to the people employed. The business model canvas does not capture the full sustainability value created, or rather it should be accounted both on the single company level as well as on the societal level in the municipalities

9.2. GENERAL CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of AVVs case study, some general conclusions and recommendations can be extracted for the further work in a transition towards a circular economy. AVV has been an extreme case, and by investigating their innovation processes and experimentations with prevention and preparation for reuse, some general learnings from the AVV case study can inform the future development of sustainable waste management, including recommendations for policy makers. These are based on the above and summarized in the following:

1. The “lock-in” to infrastructure (incineration) does not per definition hinder innovation and experimentation with more sustainable waste management solutions if other forces (organization culture, value, people) have created a platform for other solutions and experimentation
2. In the prevailing narrative “waste as a resource”, value should be understood broadly and not simply as economic value creation. In a business perspective, there is a need to couple this narrative with the triple bottom line and an aim for sustainability. A pure economic business rationale does not incentivize circular business models. Moreover, waste is

- still an environmental problem to be taken care of regardless of economic value potentials
3. Public governance of waste management is needed and since much of the value that can be extracted from the circular business models is captured at municipal level, waste management should remain a public task that could be carried out in partnerships with private actors.
 4. Creation of institutional structures is a precondition in order to encourage and support waste prevention and prepare-for-reuse. More specifically, clarity in the legal framework about rights or even requirements to operate prepare for reuse activities and prevention activities by for instance
 - a. Require to use a certain amount of the citizens' fees to preventive initiatives
 - b. Setting specific targets and requirements for preparation-for-reuse (such as Belgium's 2 % reuse of WEEE)
 - c. Develop methods to require prevention (e.g. explicitly require waste management companies and authorities to offer communication and prevention activities for citizens)
 - d. Introducing requirements for prevention and resource efficiency to other actors further up the value chain, e.g.
 - i. Less and different type of packaging
 - ii. Requirements to retailers on how to market products in a way that does not entail unnecessary consumption
 - iii. Eco-design requirements that enable repair, refurbishment and recyclability
 - e. Development of a clear political vision and goals for reuse organized by municipal waste management companies
 5. Aim for triple bottom-line results in waste management. The value creation potentials in increased preparation for reuse are environmental, but this study shows that there is a significant additional social value that can be created at local level in the form of
 - a. local jobs,
 - b. training programs,
 - c. integration of refugees,
 - d. giving the opportunity to disadvantaged citizens to buy cheaper products and thus achieve high living standards,
 - e. support up-coming businesses/entrepreneurship
 6. Experiments can pave the way for developing new solutions and new types of collaborations
 - a. Innovation for a circular economy will involve uncertainty and disagreement among actors about ends and means. Hence, a need for inviting a wide variety of regime actors, and learning and negotiating along the way.

7. Measures are needed to track waste materials by the municipal waste authority in order to ensure closing of loops. The possibilities of a municipal waste management company to make requirements to the downstream treatment and to increase demand for documentation of the actual recycling processes is an interesting topic for future studies in AVV and in waste management for a circular economy in general.

In order for society as such to transition towards a circular economy, there is a need for an interaction between all levels of the value chain. Municipal waste management companies and authorities can play an enabling role as this thesis shows, but other measures and initiatives at other levels also needs to be taken, so that every step in the value chain supports circularity and resource efficiency. Some of these measures can be made at policy level, such as eco-design requirement. How to affect the prevailing consumption culture in order for consumers and citizens to consume in more sustainable ways may be the most challenging part of the transition.

9.2.1. RECOMMENDATIONS FOR FUTURE RESEARCH

This PhD project focused on prevention, reuse and refurbishment. In terms of tonnage, much more waste is aimed for material recycling. Future research should investigate how municipalities and municipal waste management companies can ensure that the separately collected waste is treated for recycling in the best possible way. The current waste legislation presents quantitative targets for collection for recycling, not for actual recycling. As municipalities are obliged to achieve these targets, there is a risk that environmental considerations, such as the risk of spreading harmful substances, are neglected. An example of this is the waste fraction ceramics and porcelain, which contains lead. When utilizing waste ceramics in building materials such as insulation or bricks, lead may be spread to the environment. However, ceramics is heavy waste fraction contributing to achieving the recycling targets. In addition to this, there are large differences in the market prices for recycling. Suboptimal recyclers may be chosen by the municipalities due to economic saving potentials rather than pursuing the environmentally preferable solution. Finally, it may be difficult for municipalities to assess which recycling option is environmentally preferable, as this includes considerations regarding actual recycling rate, what the recycled material substitutes, which environmental impacts there are from the recycling process and more. Future research is needed to develop guidelines for municipalities on how to select appropriate recyclers, which can ensure an optimal circulation of the resources, and how the policy framework can support this.

CHAPTER 10. CONCLUSION

The purpose of the PhD projects was to investigate how a municipal waste management company can develop innovative, local and circular economy solutions and business models with a particular focus on waste prevention and reuse. I applied an ethnographic case study approach in order to closely follow, participate in and study the practical experiments and innovation processes that took place in a municipal waste management company, AVV. AVV can be considered an extreme case, because they have always experimented with solutions and activities concerning waste prevention and reuse. Public waste companies and municipal authorities cannot in general be expected to do so, because of the ambiguous legal framework. They are not legally obliged to make prevention and reuse related activities, and some political announcements like the consultancy response for the prevention strategy even state that they cannot finance such activities by the renovation tax (citizen fees) (Miljøstyrelsen, 2015). In spite of this, AVV has worked with reuse and waste prevention. The driving factors have been organizational culture and the personal interests and competences of the innovation manager and other employees present in AVV. AVV has become well-known in the waste sector for their innovative approaches to developing waste preventive and reuse oriented solution. Because of this deviating character of the case, then AVV is well-suited to shed light on what challenges and possibilities municipal waste management companies might encounter when innovating for prevention and reuse. Thus, learnings applicable to the sector in general can be derived in addition to the more company specific learnings.

The first contribution of the thesis is the proposal of a conceptual framework in the circular economy, the European Waste Hierarchy, and theories on business model innovation and sustainability is combined. This conceptual frame highlights two trajectories to in the circular economy. These concern reduction of material throughput such as prevention and waste minimization and then value maximization of the resources throughout their life cycle. Whether these two aims can in practice be pursued at the same time is uncertain especially if value is considered from a narrow business economic perspective. The conceptual framework moreover highlight the need to link circular economy business models and solutions with sustainability, so that business activities aim at a triple bottom line, thus perceiving value broadly as covering both environmental, social and economic value for the local society.

The first sub-question zoomed in on the theme of waste prevention by answering the question: *How can reduction and waste prevention be understood, conceptualized and applied within a municipal waste management company?* Through a systematic literature review, waste prevention was investigated from the perspective of the local waste manager. The environmental effects of waste prevention far exceed the effects

of any of the subsequent treatment alternatives, however good it may be. Waste preventive measures can be taken at all stages of the value chain. The municipal waste managers are mainly responsible for managing the waste once it has been generated by the citizens (cf. the waste executive order/affaldsbekendtgørelsen). Citizens are waste management companies' main customers. For this reason, the most obvious way a municipal waste management company can proactively engage in waste preventive activities is by inviting, communicating, encouraging citizens to prevent waste and provide them with practical tools on how to do so. The study also found that food and paper waste in households was the easiest waste types to avoid. At the same time, these waste types account for a large part of the daily discard, and for this reason waste management companies and authorities can specifically address these two waste types in waste prevention campaigns.

A second way that a municipal waste management company can encourage and enable waste prevention is by providing the citizens with possibilities to reuse products and thus prevent the acquisition of new products. A study points out, that consumers generally are willing to reuse (both donate and acquire second-hand goods). When reuse does not happen, this is because of lack of opportunities, infrastructures and enablers for reuse. Waste management companies can thus enable reuse for instance by operating a reuse shop or by arranging swap markets and the like. The post-consumer goods that are donated to waste management companies have a low value to the person discarding them, but waste management companies can create value for others than the original owner by establishing appropriate systems for reuse.

The difficulty to measure the effects of such prevention campaigns and reuse enabling activities can be a barrier for their further dissemination. However, a larger barrier relates to the legal framework under which municipal waste companies and authorities operate: they are not legally obliged to encourage waste prevention, and are not allowed to finance prevention activities from their main source of income, i.e. citizens fees. The legal framework thus does not incentivize municipal waste managers to embark on prevention initiatives. For this reason, it is recommended that future legal frameworks oblige municipal waste managers to initiate and support aim for waste prevention and reduction.

Municipal waste management authorities are obliged to manage the collected waste in accordance with a set of principles ranking different management options in an order of priority. To be prioritized is the preparation for reuse of waste items. Thus according to the Danish waste executive act municipalities are to prepare waste for reuse before pursuing other treatment types. However, no legal requirements are set to the quantities of waste prepared for reuse. Only specific targets exist for collection for recycling, and thus municipalities are only incentivized to pursue high collection for recycling.

In AVV, different initiatives and projects have been made to additionally achieve high reuse rates. Experiences from these initiatives have provided learnings about the challenges and barriers within the socio-technical system of waste management for municipalities in order to prioritize reuse. Moreover, these experiments have provided learnings about the value creation potentials that there are in prioritizing preparation for reuse as a treatment solution. The values that can be created from collecting and preparing post-consumer products for reuse, e.g. through refurbishment processes, are not limited to the economic bottom line of AVV as a company. Social value can be created in the local community as cheap products are offered to less-advantaged citizens. Moreover, the job creation potential in preparation for reuse activities far exceed the jobs that can be created in other waste treatment types. The simplest form of reuse (selling post-consumer products in a reuse shop) requires less labor input than the more extensive refurbishment processes in workshops like GodtGjort. A reuse shop can be an additional value proposition in a waste management company, which can even operate on viable terms, i.e. the income from the sales of post-consumer products can finance the jobs in the shop. Refurbishing post-consumer products and creating new products from waste are more comprehensively challenging in terms of business model innovation. A prerequisite for this type of circular model and value creation seem to be the willingness and ability to collaborate with external partners around the design, development and marketing of products made from waste.

Thus, public-private partnerships are recommended based on the findings in this study. Inviting to and engaging in such partnerships require an effort from the municipal waste management company or authority, but due to the benefits of such partnerships on the social welfare in the municipality, the environmental benefits, and the economic potentials that are shared with the market actor partner, it is worth pursuing.

The last sub question zoomed in on AVVs internal working practices in order to investigate to what extent the innovative ideas and values that were present in the innovation department and in the management had also been adopted by the employees at the recycling centers. The employees at the recycling centers play a central role in the enabling of circular economy solutions, because they are the ones who have the daily contact to the generators and suppliers of waste, i.e. the citizens. This study investigated the social practices at the recycling centers and pointed towards the need of creating new meanings related to waste and waste management. Among other the findings suggest that there may be oppositions between that of providing a service to the citizens and at the same time asking them to sort their waste as well as possible. Moreover, the societal narrative of “waste being a resource” tend to be understood in narrow economic and to some degree environmental terms by both citizens and by the employees at the recycling centers. Thus, the broader concept of value in relation to waste as a resource should be communicated.

As a final remark, waste prevention and reuse are solutions that only partly can replace incineration and recycling. They are solutions to be employed in addition to other waste treatment solutions and reuse can delay incineration and recycling. Nevertheless, the environmental and social benefits of waste prevention and reuse call for a more focused effort aimed at these solutions than are in practice seen in today's waste management and its governance. Further experimentation in niches can provide increased learnings about how to organize and incentives such efforts in the future.

“From waste to resources” has become a dominant discourse in society and this points out the direction of a more integrated resource management in the future. However, as illustrated throughout this PhD thesis, it takes time to unlock the current technological trajectory of incineration in Denmark, and to establish the waste prevention, reuse and refurbishment initiatives that makes this the dominant circular way of handling resources in society. This will also demand new types of collaboration and partnerships between private and public organizations as well as with NGOs/charity organizations and civil society.

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