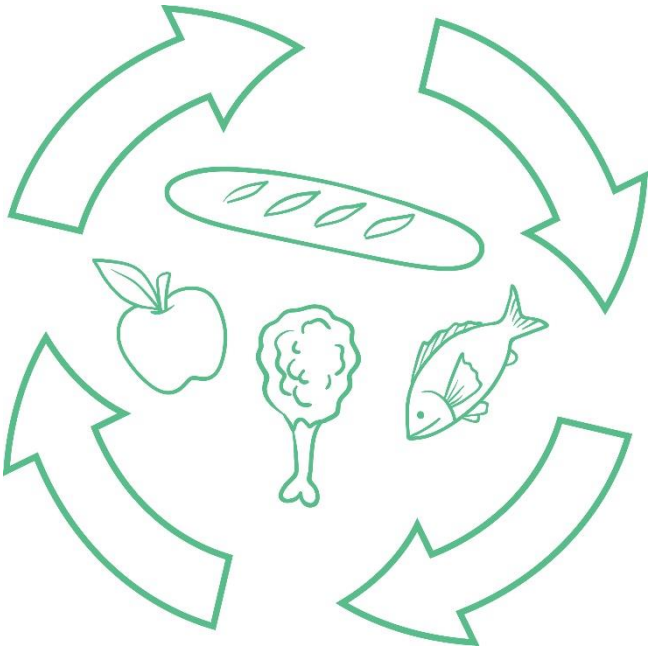
Sustainable Cities

Master Thesis

AALBORG UNIVERSITET

Study on food waste streams and creation of circular solutions on Bornholm



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Abstract

Bornholm has approved a vision on being a zero-waste island by 2032, date in which the island's incineration plant will be decommissioned. In this sense, with no clear strategy on food waste and considering it as a global issue, as more than 30% of worldwide produced food is lost (FAO data from 2017), there is a need to shift the current food waste stream into a more circular loop, where food waste is treated in a different way within the island.

Starting from 2022, waste separation at the consumers end by fraction will be mandatory, meaning organic waste will be collected in a separate stream to other fractions. Commercial waste will also subscribe to this collection system by the end of 2022. In this sense, and with the goal of creating a circular food loop that departs from the current throw-transport-burn at the plant linear model, the research aims at finding the key actors in the retail food value chain and seeking for this circularity potential.

Hence, answers to the following research questions will be pursued: What is the role of the different involved actors in the prevention of retail food waste on Bornholm? Which solution or solutions have the potential to prevent retail food waste on the island of Bornholm?

The analysis maps out existing actors and their roles within the retail food waste supply chain, as well as providing ideas on how to collaborate to prevent retail food waste on the island of Bornholm.

Acknowledgements

Thanks to Michael and Stig for their excellent work and dedication as supervisors, offering invaluable advice all along the way, always demonstrating a great deal of implication. A special thanks to my colleagues at BOFA for giving me the chance to enter the danish job market (not an easy task), which was the main reason why I decided to leave my country and get back to studying in the first place. Further thanks to all of those who gave me their time and interest, participating via interviews in this research.

And thanks for those friends and family that support me, knowing that behind all the anecdotes, fun and jokes about living overseas there is a great deal of personal sacrifice.

Contents

Introduction

Currently, the world demands a total annual production of 4.3 billion tons of food, for human consumption. In order to satisfy this demand, a complex supply food management system is put into practice. This system has responded to a fast-growing population, economic growth and urban development (Ellen MacArthur Foundation, 2019). Now, after that production tonnage, 1.3 billion tons of food are wasted, along different points of the food production chain, which accounts for over 30% total food loss (Food loss and waste facts, 2015).

At the same time, EU legislation on the subject of waste is demanding a lot of effort to comply with future plans, which implies that following business-as-usual is a dead-end road. This means that prevention of waste is the most effective measure (Jensen et al., 2019).

The food consumption trend is expected to continue for decades, reaching a 60% increase on global food demand by 2050 (Alexandratos and Bruinsma, 2012). Speaking of resources, food production requires a significant number of them such as fertilizers, energy, water, land and labour. So, wasting food can be seen as both a waste of resources, as well as a contributing factor to climate change (Halloran et al., 2014). To better understand the origin of these problems, the supply chain should be acknowledged. In this case, the food supply chain follows the following stages:

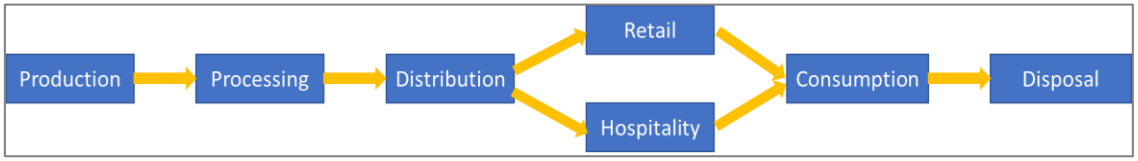

Figure 1. Basic food supply chain. Source: author, adapted from Ellen MacArthur Foundation.

Specifying the problem implies defining first what is considered food waste for this study. Generally, food waste is divided into two fractions: food (edible) and inedible parts of food removed from the food supply chain to be recovered or disposed (Stenmarck, Jensen, Quested and Moates, 2016).

Food waste takes place at every level of the food supply chain, for example, as edible crops left on the field, losses during transportation, discards during the packaging phase, losses at the retail phase or at the household (Halloran et al., 2014).

At this point and answering to the urgency of reducing food waste to improve food security, sustainability of food systems and their associated emission of greenhouse gases (Halloran et al., 2014), food waste will be addressed as that appropriate for human consumption that is discarded (HLPE, 2014).

Within Denmark most food waste is incinerated for energy recovery, yet, although there is an absence of economic incentives to reduce food waste, several initiatives have emerged to prevent it in the last years, both from private and public origins (Halloran et al., 2014).

Within this country, the case of interest is drawn from the island of Bornholm, which in 2018 adopted a zero-waste vision for 2032, date in which the island's waste incineration plant will be decommissioned (BOFA, 2019). Hence, this gives opportunity for innovation within food waste, as its currently way of disposal (incineration) will be replaced by one, or several options that are yet to be decided.

The aim of this thesis is to investigate real opportunities on food waste prevention in the island of Bornholm. Specifically, this food waste will be that coming from the retail sector, as it is one waste stream currently processed by BOFA (waste management public company), that should undergo a radical change in order to accomplish the 2032 vision.

Background (I): Food waste and the supply chain

Food waste is considered a major social, nutritional, and environmental issue affecting the whole food supply chain. Not only food waste and losses account for 1.3 billion tonnes every year, but this has further implication if we speak of resources (FAO, 2011). Food waste negatively affects the environment, in the form of methane emissions from landfilling, carbon emissions throughout the supply chain, including incineration practices, and in the form of agricultural conversion of natural ecosystems, just to list a few (Lee and Tongarlak, 2017).

Worldwide, we use 51 million km^2 of land for agricultural use, which is 34% or the Earth's land space. From this quantity, 40 km^2 are used for livestock, whereas 11 million km^2 are used for crops. Furthermore, water use for food represents 70% of all water withdrawals (United Nations Environment, 2019).

In terms of emissions, food waste accounted for 4.4 $GtCO_2$ eq per year, with data drawn from food waste volumes, Life Cycle Assessment studies and land change use (FAO,2015). If food loss and wastage were a country, it would be the third biggest source of GHG emissions, only exceeded by China and the USA. At the same time, 690 million people were hungry in 2019, and this number is expected to rise during and after the COVID 19 pandemic (United Nations Environment Programme, 2021).

Its causes are motivated by different factors along all stages of the supply chain (Cicatiello et al., 2017) and include lack of coordination between actors, as well as cultural, social, and economic factors (FAO, 2011). Furthermore, this issue is also approach by the 2030 Sustainable Development Goals set by the UN, being linked directly with SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture, and SDG 12: Ensure sustainable consumption and production patterns (THE 17 GOALS | Sustainable Development, n.d.). With this background, working with a food system that systematically discards around one third of its whole production seems like an unsustainable practice.

So, food waste reduction is a three-in-one gain: it increases the total amount of available food, reduces pressure on land for production use and reduces environmental impacts such as water resources and GHG emissions (Møller et al., 2014). Food waste reduction is currently fought against via legislation, there is little economic incentive to reduce food waste in the supply chain. Food waste starts in the production phase, where uncertainties on the daily ordering quantities can lead to overproduction of produce. A "just in time" demand would be needed to reduce waste here, though, there will always be unforeseen losses, for example as a consequence of bad weather episodes.

The next phase of the chain is the processing stage. Here, food items can be discarded due to size or shape, as some of them will not meet the marketing and distribution aesthetic standards set by retailers. These standards are not based on safety or security criteria, meaning perfectly edible produce are discarded (Halloran et al., 2014). In terms of transport and distribution, there are also risks of losses due to accidents or delays.

The next step of the supply chain brings us to distributors/retailers. Retail selling process is challenging, mainly because demand is uncertain and products are perishable (Lee and Tongarlak, 2017), which troubles the matching of supply with demand. In order to prevent food waste in this stage, retailers primarily try to optimise their operation via category management, which includes finding the right balance between, for example, product range, new product

promotion, shelf design and organisation or point sale of advertising. Further, the EU regulation of “best before” date seeks at a balance of food security and food waste reduction and solving this issue should come from awareness campaigns for customer education (Halloran et al., 2014).

In terms of relative amount, retail food waste (including supermarkets, wholesale, and specialised stores such as bakeries or fisheries) accounts for 24% of the whole food wasted along the supply chain in Denmark, with 172,300 tonnes (Econet, 2014) of a total 716,000 tonnes (Tonini, Brogaarf and Astrup, 2017). Though not the biggest contributor of food waste (first one is households, with 260,000 tonnes), the retail sector has a big influential power over consumers and still wastes mostly packed and sealed products, throwing away food that still is edible.

Yet, which are the main reasons why food is wasted in the retail sector? The main reason, legality. Food operators are required by EU legislation to mark almost all packed foods ready to deliver to the consumer. There are two types of labelling: “best before” and “use by”. The first one indicates that though the product should be safe to eat after that date, it will start to lose quality, whereas the “use by” label indicates it should not be used after the date. Food that has past these dates cannot be sold to the consumers (Møller et al., 2014).

So, with the numbers of food waste, it can be assumed that many shops order more than they can sell. Some of the reasons for this respond to economic strategies. Firstly, supermarket shelves should always appear fully stacked, ensuring the customers products are always available. This is done to prevent customer dissatisfaction and goes deliberately beyond the law of supply and demand.

With this overstocking, profit margins are still beneficial for retailers. At the end of the day, having stock surplus in the store potentially generates more profit than having half-empty shelves. As mentioned previously, matching supply and demand in food orders is not an easy task, either. This is evident, too, by the variability of retail food waste types. Another source of retail food waste is damaged packaging, which can consist of a spill or tear on the outer packaging, on many occasions leaving the food inside unaffected, but supermarkets still opt on throwing it away (Stuart, 2009).

Figure 2. Empty shelves at a supermarket. Source: AFP.

Having this in mind, the study of food waste in the retail sector is further interesting due to several factors: (i) the retail sector has a strong influence on both shaping the features of food production and consumers' preferences; (ii) absolute quantities of waste at retail stores are quite significant with respect to the much more food scattered at other stages of the supply chain, (iii) retail stores are places where multiple actors within the supply chain intersect (Cicatello et al., 2017).

At a European legislation perspective, it is acknowledged waste management should be improved and transform into a sustainable material management. Legislation further recognises the management of municipal waste is a highly complex system that requires active engagement of citizens and businesses and includes retail food waste within the definition of municipal waste (European Commission, 2018).

In terms of particular goals, the EU and its member states have committed to reduce by 50% per capita food waste at the retail and consumer level by 2030, as well as reducing food losses along the food supply chain, which corresponds to SDG 12.3 (EU actions against food waste - Food Safety - European Commission, n.d.). However, it is up to the Member States to legislate to comply with these goals.

In Denmark, there have been intentions of legislating on food waste and regulating its use for biofuel, animal feed or charities (S er klar til at forbyde madspild i supermarkeder, 2019), yet there is currently no law in force that specifically tackles food waste. The only legislation tackling food waste the 50% recycling goal at the household level by 2022 to cut down on incineration, which includes organic waste as one of the fractions (Ministry of Environment of Denmark, 2013), but does not imply the retail sector.

MAIN TAKEAWAYS – FOOD WASTE AND THE SUPPLY CHAIN

- Food waste is a major social, nutritional, and environmental problem. Current food system discards over 30% of its production.
- Reducing food waste is beneficial because: it increases the total amount of available food, reduces land pressure and environmental impact.
- Retail food waste accounts for 24% of the whole food wasted along the supply chain.
- Retail sector has a big influential power over consumers, and food waste responds to several factors, including legal and marketing aspects. It is also a place where multiple actors in the supply chain meet.
- Currently there is no law directly addressing retail food waste in Denmark.

Background (II): the case of Bornholm

Bornholm presents a unique setting. Being an island in the Baltic Sea, and part of Denmark, its innovative vision paves the path to follow towards circular economy in the whole country. With ca. 40,000 inhabitants, this place frequently fails to reach a critical mass for public services (Christensen, Hjul-Nielsen, Moalem and Johansen, 2020).

Now, the island poses a special case in terms of their waste management transition. This is due to their 2032 vision, year when the waste incinerator will be decommissioned as the island will simultaneously adopt a zero-waste vision, making it a leading example on the phasing out of waste incinerators in Denmark (BOFA, 2019). At the same time, closing the loop of resources, consumption and waste generation brings the circular economy term on board. Due to this vision, waste management strategies will completely depart from incineration and landfilling as treatment options towards recycling, reusing, and preventing (Christensen, Hjul-Nielsen, Moalem and Johansen, 2020).

In this sense, circular economy further brings the need of research towards challenges, opportunities, and effective collaboration between stakeholders (Franco-García, Carpio-Aguilar and Bressers, 2019).

The main vision, to eliminate incineration, recycle and reuse, is accompanied by several further goals that reach the whole society. These goals, as well as the different timeframes and scopes, are shown hereunder:

Table 1. Goals, time periods and tracks of action for the 2032 zero waste vision. Source: BOFA.

Goals	Time periods	Tracks of action
Children will receive education in sustainability and was related topics. **Repair cafes** will prevent usable products to be discarded. Tourists and visitors to Bornholm will actively participate in the first waste-free society. A **waste and resource cluster** will be created with new and established businesses to serve as a knowledge centre and an international showroom.	**Near future**: 2019-2022, where requirements and measures are known. **Slightly distant future**: 2023-2026, where there will be knowledge on legislative requirements and available technologies. **Distant future**: 2027-2032, where new legislative requirements and technological developments cannot be predicted.	Prevention, Collection, Treatment and outlets, Learning and knowledge, Communication and dialogue, Organisation, Economy.

This ambitious goal, especially when compared with the current situation, requires an intense effort and R&D activities both to study technical and societal systems, as the feasibility of a zero-waste society it yet to be proven. Further, research on sustainability transition show that these types of challenges demand system innovation, which means changing how socio-technical systems are working today (von Wirth, Fuenfschilling, Frantzeskaki and Coenen, 2018).

The case of Bornholm aims at showing that these socio-technical solutions can come through unlocking green minds, creating innovative partnerships and experimentation approaches. These factors can make waste prevention and the preparation for reuse and recycling a reality, complying with the inner circles of circular economy (Christensen, Hjul-Nielsen, Moalem and Johansen, 2020).

So, new socio-technical solutions for today's way of dealing with waste must be explored and eventually implemented. The current waste stream for food waste island follows a linear flow, which is presented in the following figure:

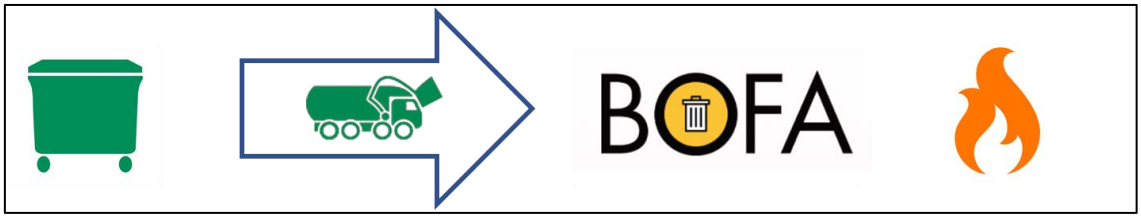

Figure 3. Basic flow of retail food waste on Bornholm. Source: author.

Now, the retail sector offers an attractive study case, as, contrasting to what happens at other phases of the supply chain, their food waste includes products that, though being unsalable from the retailers' view, are still apt for human consumption (Cicatiello et al., 2017). Furthermore, retailers, are seen as an actor of influence on the food waste generated throughout the value chain.

As waste is a tangible and visible problem, it can draw attention and affect reputation of the retailers among employees, consumers and other actors. At the same time, retailers are able to bring changes, disseminate innovations and play a coordinating role for food waste prevention practices (Colombo de Moraes et al., 2020). Retailers in Europe know that it is within their environmental responsibility to deliver food in a more sustainable model, by contacting with consumers and other actors (Zhong, Xu and Wang, 2017). These factors, combined with the case that through innovative partnerships and an experimentation approach, it is possible to prevent waste on the island of Bornholm (Christensen, Hjul-Nielsen, Moalem and Johansen, 2020), makes the retail food waste a potential object for further investigation on the island.

Food waste from the retail and wholesale sectors is generally handled as mixed municipal solid waste in Denmark (Halloran et al., 2014). More specifically, Danish legislation establishes that municipalities must implement separate collection schemes from households no later than January 1st, 2022, and waste-generating companies (the commercial sector) must follow the same separation scheme as latest on December 31st, 2022 (Miljøministeriet, 2020).

In Bornholm, the waste management entity on the island is on the process of selecting the new waste operator for the period 2022 – 2031 (with a possibility of 2-year extension), which calls for a big tender process. The Municipality is offering a contract for the collection of household and commercial waste in the following fractions: residual waste, plastic, cardboard, paper, glass, food waste, mixed small batteries, small electronics, metal, hazardous waste, textiles and composite (Bornholms Affaldsbehandling, 2020). The winning entity, as of May 2021, is yet to be announced.

Current situation on the food waste handling on the island is as follows: waste from the retailers is transported by the two waste transport companies on the island (Marius Pedersen and Lennart Ipsen) to BOFA's main site for incineration, just outside Rønne. This waste from retailers,

however, not only includes food but all the other items or materials thrown away by supermarkets, that are discarded in the same containers and thus collected as one mixed stream.

The waste that arrives at BOFA cannot be further treated by the waste management company, whose role is to weigh it, record this data, and make sure the truck empties it into the pile for incineration.

Bornholm currently counts with 29 supermarkets/coop stores, which are represented by 5 Netto stores, 2 Fakta, 2 Lidl, 12 Super and Dagli brugsen, 2 REMA 1000, 3 SPAR, 1 Meny and 2 Kvickly. They are distributed around the island is as follows:

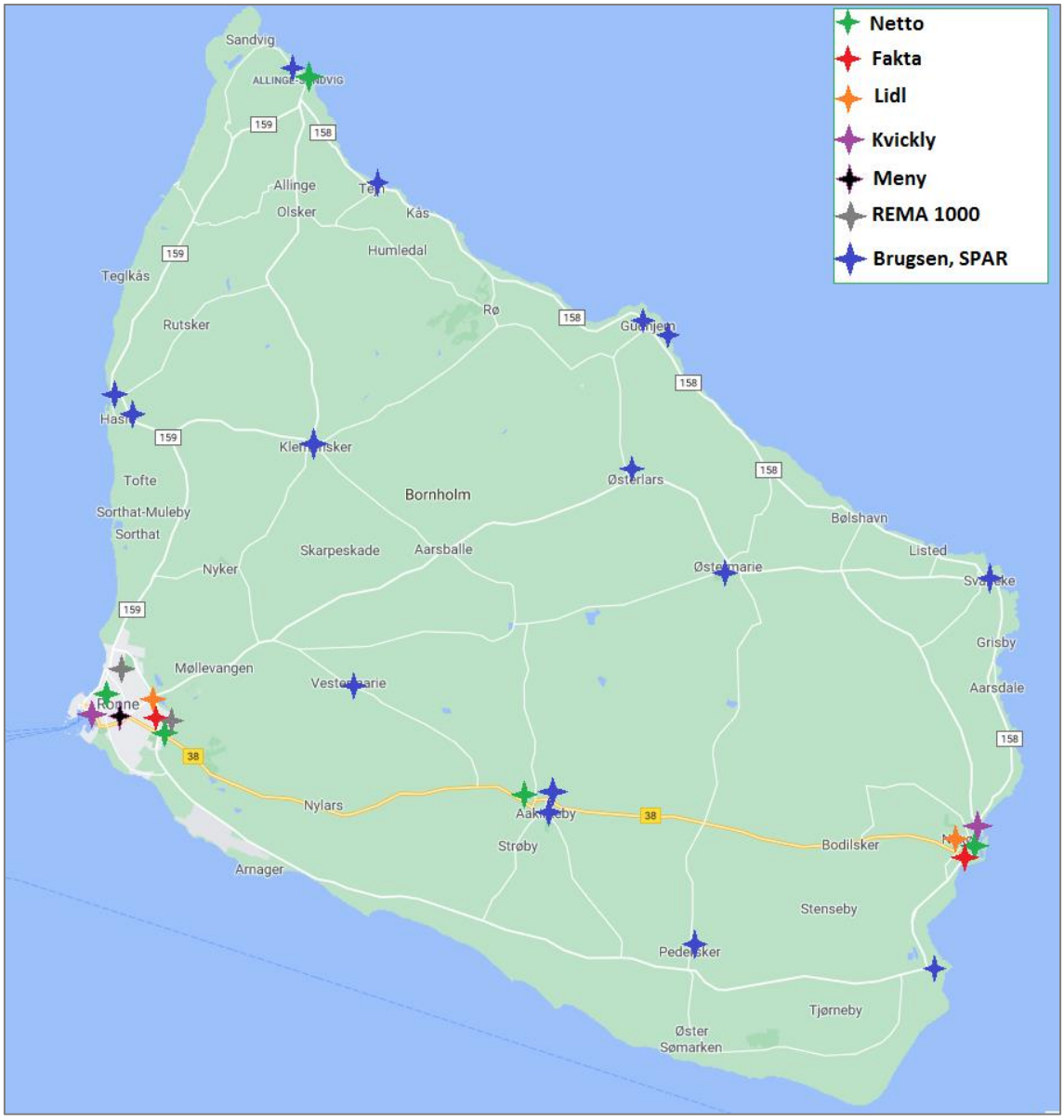

Figure 4. Distribution map with the supermarkets on the island. Source: google, author.

The problem arises though, in the lack of a specific solution or list of solutions to prevent this food waste or recirculate it in any other ways besides the current one. This leads us to the problem area.

MAIN TAKEAWAYS – THE CASE OF BORNHOLM

- Bornholm has approved the 2032 zero-waste vision for the island, year in which the incinerator will be decommissioned.
- The vision implies that prevention, reuse and recycling of waste will be prioritised following the waste management hierarchy.
- Currently, retail food waste arrives in trucks (mixed with other non-food waste) and incinerated at BOFA.
- Bornholm's waste operator for the period 2022-2031 is to be expectedly announced (after a long tender process), in June-July 2021.

Problem Area and Research Questions

At this point the problem can be narrowed down. An estimated 515.000 kilos of food waste is generated by the retail sector on the island of Bornholm (Econet, 2017), which is currently incinerated.

Parallelly, this island´s 2032 vision and disassembling of the incineration plant present a future challenge on how to treat these amounts. Adopting circular economy measures is especially challenging in the food sector as compared to other ones, because food, by nature, degrades after consumption in a way car components, a door or a mug does not, hence it cannot be recycled in such a way (Ellen McArthur Foundation, 2013).

Whereas household waste is subject to national goals, as previously mentioned, retail food waste brings a challenge for waste management entities that are transitioning to more sustainable practices like BOFA. Besides the environmental effects of food waste, uncertainty on how much food waste can be post-processed for animal feed, digestion or compost is high and a problem yet to be solved.

Considering the 2032 zero-waste vision, BOFA will have to process all the food waste in a completely different manner as it is processed today, and thus separating food waste from households, retail and hospitality sectors seems like a good starting point. Considering both the vision and the food waste hierarchy, looking for prevention measures is the logical step.

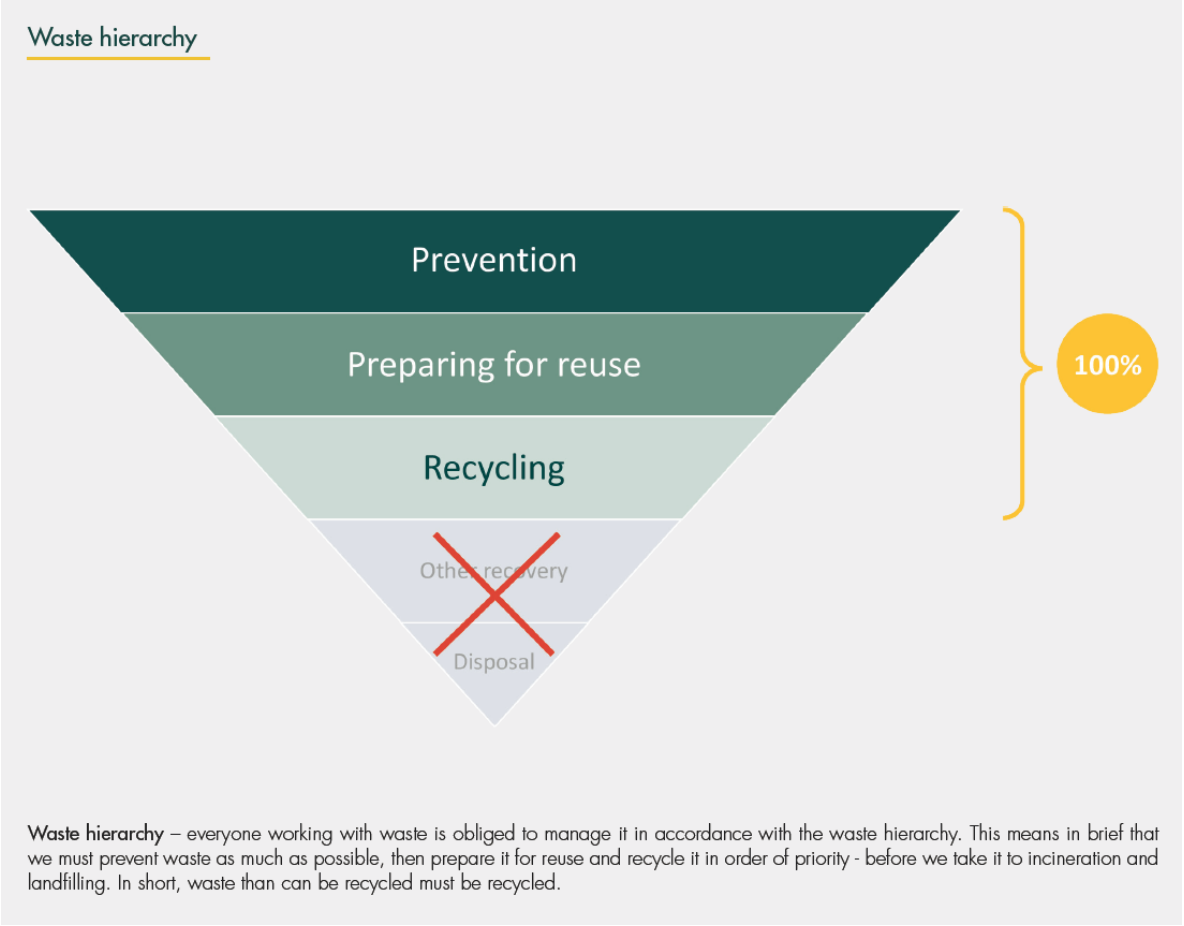

Figure 5. Waste hierarchy and 2032 zero-waste vision. Source: BOFA.

Though the food and waste sector have different business logics and only sparsely connect to develop collaborations, both sectors are connected through retailers. The retail sector thus plays an important role, as a link between, on one hand, stakeholders in the supply chain with their particular logic and interests, and consumers, authorities and waste handlers (with their particular interests) on the other. Now, in order to seek and develop solutions for sustainability, that lead towards circular economy, collaboration between these parties is necessary (Halloran et al., 2014).

So, the next step, is to study state of the art retail food waste prevention initiatives in Denmark, followed by the exploration of their applicability in Bornholm, considering its condition of geographical insularity. At this point, research leads to analysing the roles and interests of the different actors in the food supply chain on the island.

This is carried out in the hopes that further research can thus bring a viable solution, or group of solutions, that can potentially prevent retail food waste in Bornholm involving several of the actors involved in the supply chain.

These considerations bring us to the research questions:

RQ_1: What is the role of the different involved actors in the prevention of retail food waste on Bornholm?

RQ_2: Which solution or solutions have the potential to prevent retail food waste on the island of Bornholm?

Delimitation

In this context, and in order to comply with the goal of 50% recycling of household waste into 7 fractions, including food, in 2022 (Ministry of Environment of Denmark, 2013) and thus with the separate collection of waste in these fractions (Miljøministeriet, 2020), BOFA is currently in the process of resolving the big tender for waste collection for the period 2022-2031, whose results are expected to be made public by June 2021. This has taken a big amount of the workload from the managerial personnel at BOFA, during the last months.

Thus, anything outside of the tender process, such as plans on food waste treatments, which include prevention, are on the table of ideas, but there is no document that specifically discusses them – or any officially approved decision on this regard. As of the presentation of this research (June 2021), the most recent ideas for this were discussed at a content meeting held at BOFA on the 19th of May 2021 with Henrik Larsen, Mette Butzbach, Harnne Nørregaard, David Christensen and Vicente Bueso. This meeting included discussions about the Sustainable Food Week, a nationwide event that was to be held in March 2021 on Bornholm but, due to the COVID-19 pandemic, will now be held on the island expectedly on the last week of September 2021.

This event gathers leading companies from the food, energy and process technology industry and Master and Ph.D. students from all around the world to come up with innovative solutions (including, about food waste) via cross collaborations, under a working lab atmosphere. Case groups will consist of both company representatives, experts, and students, with a strong link to local and relevant businesses. As of now, CHR Hansen, Grundfos, Novozymes and BOFA have confirmed their assistance and previous participating companies include Arla Foods, DuPont, Danish Crown and more (Clemensen, 2021).

The content of the meeting held at BOFA was therefor to discuss the importance of this for the waste management entity, as it is expected to publish another tender on food waste treatment by summer, but this fact would overlap with the celebration of the Sustainable Food Week in September, when valuable solutions can be generated but perhaps their applicability is limited due to the tender already being public, not including potential innovations.

Hence, conversations are ongoing as of now (June 2021) and taking a decision in one or another direction could limit the applicability of the research presented in this paper. This is a delimitation, as if BOFA were to decide all food waste should be treated for energy recovery at the biogas plant in the short term, innovative ideas coming from this or other propositions (for example, during the Sustainable Food Week to be held in September 2021), could be not seen as priorities and hence not draw the desired interest that could be drawn under different conditions.

MAIN TAKEAWAYS – PROBLEM AREA AND RESEARCH QUESTIONS

- Retail sector generates 515.000 kilos of waste every year, which is currently incinerated.
- According to the zero-waste vision, this waste will have to be prevented, reused or recycled. Regarding the waste hierarchy, can prevention measures be explored?
- What solutions on retail food waste prevention are being applied currently?
- Which actors on the retail food waste supply chain can be interested in prevention on Bornholm?

Research Design

To initiate any research, it is important to define the scope, and the approach to the research project. This Master Thesis aims to exploring previous research on food waste streams from retail sector and using it to explore real possibilities on closing the loop initiatives on Bornholm, considering that the current processing of this waste (incineration) will be phased out in 2032.

To acquire the existential, and initial knowledge it is needed to research on current food waste prevention initiatives or business models in Denmark. This descriptive knowledge is obtained by the study of different reports and papers.

Once the research field narrows down, so does the document analysis, as more specific information is pursued (one that particularises to Bornholm). So, after obtaining sufficient data on current food waste prevention initiatives, it was necessary to obtain data of the situation on Bornholm. For this analysis, one report was studied, and the rest of the information came from interviews. As the initial information was pursuing specific, objective information, the first interviews were structured.

This part of the analysis aimed at knowing and understanding the different positions of stakeholders in the food waste value chain, so the chosen theoretical framework was Actor Network Theory.

Now, to process this data found by a narrowed literature review and structured interviews with the goal of proposing a new solution, further interviews were held. As the subject of them was to create something new (in this case, a new model on treating food waste based on circularity), the interviews were semi structured. The point of this was to further know the interviewees personal opinions, based on their experience and views, for the adoption of new solutions.

At this point, the understanding of the relations between different actors in the food supply chain, and the networks they represent, is known. Thus, based upon this knowledge, the research continues, narrowing down the possibilities to explore new forms of collaborations that aim at solving the problem of retail food waste applying prevention measures.

This part of the analysis processes this information to create a new model, which is evaluated under the business model canvas. The idea of this is to study the feasibility of this new solution under a real situation when old model of incinerating waste will be discarded, being able to identify the characteristics and scope of this new, circular model to close the loop of retail food waste.

Subsequently, the discussion aims at pinpointing and debating the novelties, weaknesses and opportunities presented by the models in the analyses. Here, a recognition on the validity and feasibility of the solutions will be argued, based, too, on the knowledge of the positions of different actors in the food supply chain on the island, their relationships, and dependences, basically, the networks they belong to.

Lastly, the research ends with the final comments, justifying if the knowledge generated during the research process can satisfactorily answer the research questions formulated at the initial phases of the research.

Visually, this research design is represented as follows:

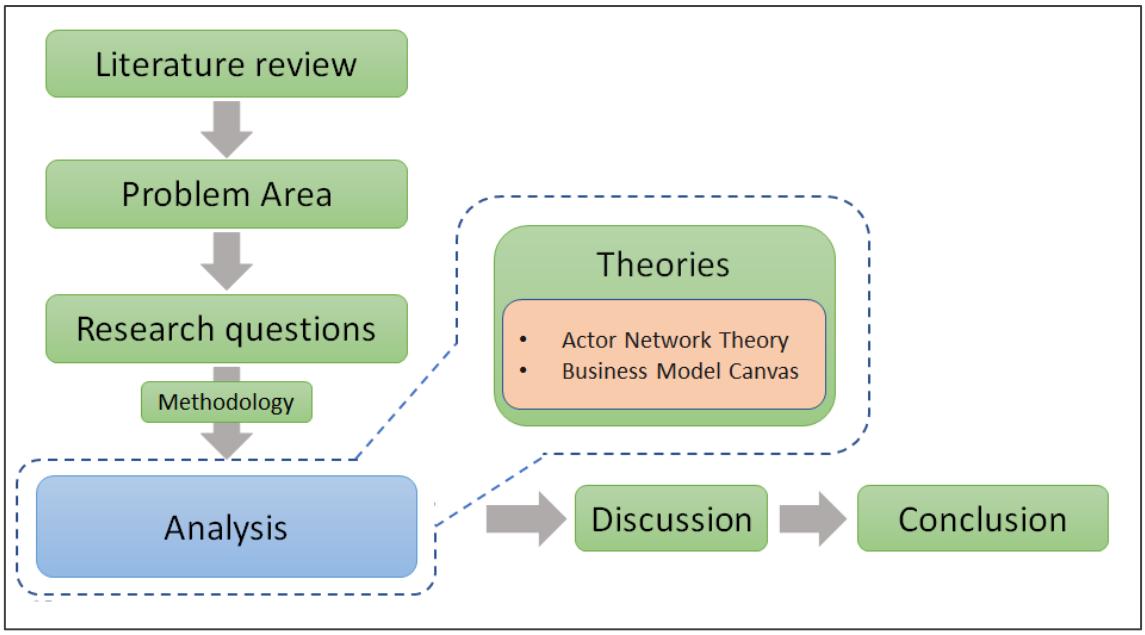

Figure 6. Research Design diagram. Source: author.

Hence, the report is structured in a way that the research process is also represented. Initially, the literature review process was used to build upon the problem of food waste and specifically the retail sector. This also matched with the research observations held on site in Bornholm, due to the daily routine of working at a waste management company and a genuine interest on food systems. Further literature review was focused on the more suitable theoretical frameworks to elaborate on the research. It corresponds with the Background and Theoretical Framework sections.

Further, the initial observations and informal conversations led to specific interviews about the food waste supply chain with relevant actors on the island, which is the main part of the Actor Network Theory Analysis.

Once these actors' ideas, roles and interests were mapped out, an exploration of possible activities to prevent retail food waste on the island was carried out using the business model canvas for circular economy, to theoretical prove their feasibility. This corresponds with the second part of the Analysis.

Theoretical framework

The problem of food waste is a complex one globally, as it carries not only sustainability implications but those of social equality, such as world hunger. Food waste has a further impact in the context of availability of natural resources.

Hence, the study of technical, social, and managerial aspects to help decrease ways and understanding its reasons is critical (Colombo de Moraes et al., 2020). So, when narrowing down the object of study a range of actors with different roles and responsibilities are identified, which include, but are not limited to food producers, distributors, retailers, waste management entities and civil society organisations.

Regarding the way of treating food waste in the context of the 2032 zero waste vision, there is a radical change foreseen in the next decade, from a situation where retail food waste is discarded in containers, along with other types of waste, and transported to an incineration facility, to a situation where there will be no incineration.

Regardless of the solution to adopt, this will depart completely from the way retail food waste has been treated in Bornholm since 1986. Further considering sustainability as the main drive of future development on Bornholm (BOFA, 2019), it can be argued that the new solution will present itself as a sustainable innovation.

Sustainable innovations are innovations that reduce or improve economic, environmental and/or social impact. In managing sustainability challenges, tensions within the aforementioned impacts can arise, as a solution for one could be detrimental to that of another (Aka, 2019).

Within sustainability, open research is an evolving space between human and nonhuman interactions, in the presence of environmental, social, and economic interests and constraints (Guthey, Whiteman and Elmes, 2014).

Given these considerations, actor network theory provides the theoretical tools to address such challenges.

On the other hand, the study aims at providing a feasible solution or group of solutions that can help prevent retail food waste on Bornholm. In order to put this into practice, at least theoretically, a transition has to occur, in a way that the existing model of retail food waste evolves into a new one that prevents waste.

So, this part of the research will aim at describing how the different actors (organisations) involved in the retail food waste sector can create value by offering a new solution for food waste in the community. Business models often go beyond revenue models, including new services and technological or resource configurations, so, these aspects will be evaluated with the business model canvas (De Reuver, Bouwman and Haaker, 2013).

Actor Network Theory

Actor Network Theory (ANT), also known as the sociology of translation, attempts at showing the relation between its two terms: actor and network. It aims to show how they are both constructed and provide tools to analyse the process (Callon, 2001). ANT's original ideas on sociotechnical engineering, are based on the process of learning and finding new ways of creating capabilities and argues that translations are central to the actor-network explanation (Steen, 2010).

Now, considering these translations as society's changes, ANT provides analytical tools to explain the processes by which society is reconfiguring itself continuously (Callon, 2001). To explain these reconfigurations, the existence of a sociotechnical system (and by extension, a sociotechnical network) should be acknowledged.

Sociotechnical systems (STS) can be defined as a recognition of the interaction between people and technology. Furthermore, STS can also be seen as the interaction between people's behaviour and how it is influenced both by social norms and technical structures. Socio-technical systems consist of a bulk of elements including regulations, cultural meaning, infrastructure, maintenance networks, supply networks and user practices and markets (Geels 2004). This means that looking at a socio-technical system is both understanding the social and technical side of a system.

Hence, these societal changes are possible because there is an existing sociotechnical network. This network is active, reinforcing the term of actor network. Every human and nonhuman element and interaction included in it, participate in a collective action (Callon, 2001). To put it in other words, ANT proposes that knowledge is generated as an outcome of a heterogeneous network of people, texts, and devices (Steen, 2010).

Parallelly, and particularising to this research, it can be argued that moving from a linear food waste stream (discarded, transported to the waste treatment facility and burnt) to one a circular one which reduces/prevents food waste presents a sustainable innovation, which as previously mentioned, is suitable to be analysed via ANT, as it provides the tools to answer questions presented within these innovations (Aka, 2019).

ANT is further seen as an open building site, not a finished construction (Canon, 2001). Equivalently, in sustainability thinking, this same space is seen as an open, evolving arena of interactions between human and nonhumans, with the corresponding environmental, social, and economic interests (Aka, 2019), which result in a convenient framework.

Once it is harvested or produced, food should be stored, transported, and retailed to reach the final consumers by due date (Zhong, Xu and Wang, 2017). So, in this research, the open building site can be interpreted as the food waste stream, whereas the different actors include all the elements in this value chain (such as retailers, waste management entities and consumers), and the network will be the relations, regulations and interests in transitioning from a linear food waste stream into a circular one that prevents food waste.

Particularising further, the initial analysis will use ANT to identify, classify and study the different actors, their relations, and networks within the food waste stream on the island of Bornholm.

Business Model Canvas

Today´s model of linear economic activity and consumption, or that of ´create-use-dispose´ creates problems in an increasing manner. These problems associated with the linear economy model, are widely addressed by creating alternative close-loop models in production and consumption. Shifting from the current, linear economy model to a circular economy would bring both economic savings and reduce the negative environmental impact of these activities (Lewandowski, 2016).

So, the transition to a circular economy is based on the following essential pillars: (a) circular economy design, focused on design that promotes reusing and recycling; (b) new business models (circular economy ones), that replace existing ones or seize new opportunities; (c) reverse cycles, that ensure the final returns of materials to the soil or back into the industrial production system; (d) enablers and favourable system conditions, that facilitate the widespread reuse of materials and higher productivity, such as effective collaborations, rethinking incentives, suitable international environmental rules, etc. (Building Blocks Of A Circular Economy - Circular Economy Design & Circular Economy Business Models, 2017).

Bearing this in mind, transitioning to a circular economy require a systemic change at all levels, and this includes the implementation of alternative business models, broader relationships with suppliers and clients and logistical changes (Daou et al., 2020).

The subject of this study, retail food waste, comprises of an intensive use of resources that are wasted as a response to a linear, arguably obsolete, economic model. Circular economy involves an improved and efficient valuation of resources, that require new business models to be implemented (Daou et al., 2020).

Thus, this is the underlying concept of applying Business Model Canvas (BMC) in the proposition of a solution or solutions that can replace the existing model of retail food waste disposal into an updated solution that integrates circular economy principles.

Traditionally, BMC includes the following characteristics:

- Customer segment.
- Value proposition seeking customer satisfaction.
- Channels to deliver and communicate the value proposition.
- Customer relationships built and maintained by the organisation, within each segment.
- Revenue resulting from value proposition delivered to customers.
- Key resources: the essential assets to deliver the aforementioned elements.
- Key activities: performed to deliver the aforementioned elements.
- Key partnerships: network of suppliers and partners that support the business model, providing some resources and performing some activities.
- Cost structure: includes all incurred costs when operating the business model (Lewandowski, 2016).

These characteristics have been classically represented as a design tool, following the format:

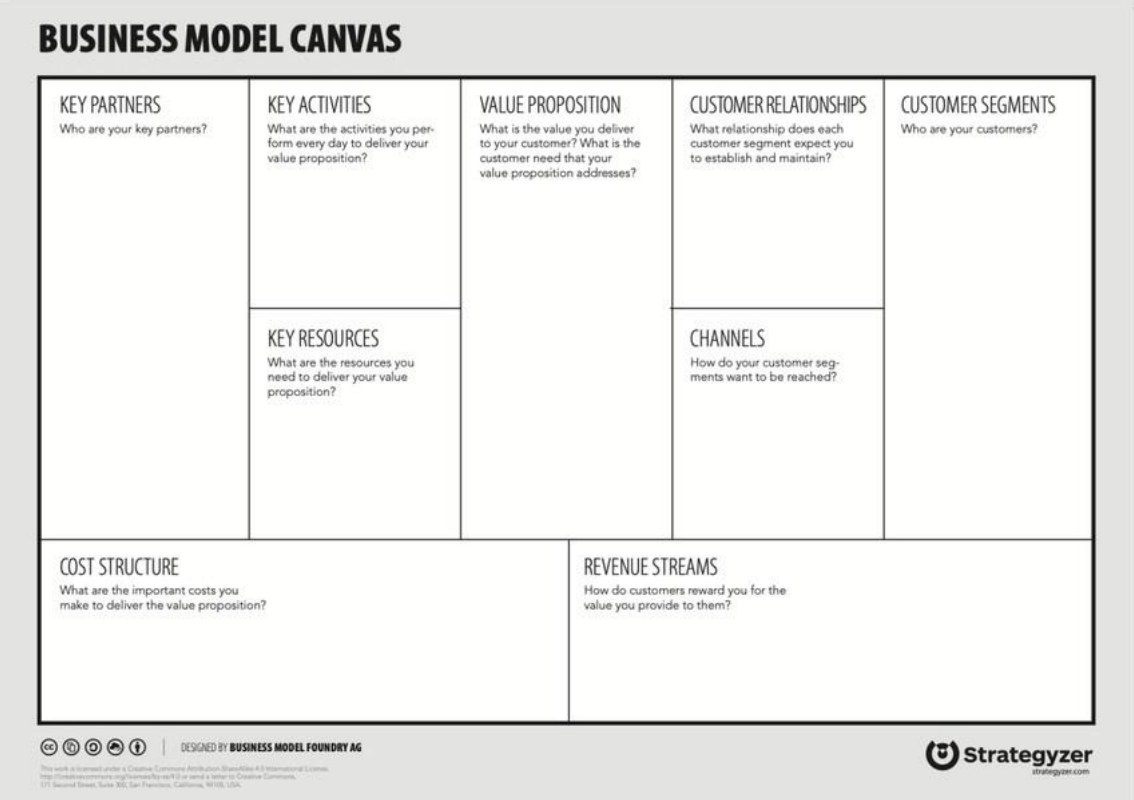

Figure 7. Business Model Canvas. source: strategyzer.

Business models adopting circularity have been defined as models in which value creation is based on the utilization of retained economic value in products, after their use in production of new offerings (Linder and Williander, 2015). Particularising to this research, retail food waste will cease in being treated as conventional waste, and instead be integrated in a new economic model that creates value.

The key areas for integration of circular economy principles with the conventional business model are as follows:

- Sales model: shift from selling volumes of products to maximisation of productivity, through service selling and creating incentives to return products after first life.
- Product design/material composition: shift from lowest possible cost for a series of features, towards a design that maximises high quality reuse.
- IT/Data management: application of tracking systems for product and materials' data, as an enabler for resource optimisation and effective return logistics.
- Supply loops: to extract additional value from material flows, maximising recovery of assets to use for recycling material.
- Strategic sourcing for own operations: to decouple economic growth from the use of natural resources, building trusted partnerships and long-term relations with suppliers and customers is crucial.
- HR/incentives: the shift requires a culture adaptation and development of new capabilities, where performance and reward schemes should be implemented to stimulate change in mindset (Laubscher and Marinelli, 2014).

Following these principles and considering a more holistic approach to conventional business models that includes cooperation, collaborations and adapting organisations to sustainability, a

circular business model canvas is adjusted following the business model generation guidelines presented by Osterwalder and Pigneur. The features of circular economy within the general structure of the business model canvas, can be interpreted generically as follows:

- Value proposition: those offered by circular solutions that enable product or resource life extension,
- Customer segments: those directly attracted by the value proposition,
- Channels: possibly with a higher degree of digitalisation and digital media,
- Customer relationships: giving more decision to customers, possibly co-designing solutions, and fostering a better relationship with the community,
- Revenue streams: relying on the value proposition, performance related to the offered service or revenue from resources retrieved from material loops (perhaps as savings with regards to previous solutions),
- Key resources: resources obtained that are meant for recirculation in material loops,
- Key activities: equipment, process, and technological changes, improving product or process design to close the material loops,
- Key partnerships: focused on cooperating with partners that support circular economy implementation,
- Cost structure: reflect financial changes departing from the conventional model, including special evaluation criteria,
- Take-Back System: design of take-back management system,
- Adoption fractions: seeking support from new organisational capabilities and external factors (Osterwalder and Pigneur, 2010).

These new characteristics are represented under the circular business model canvas:

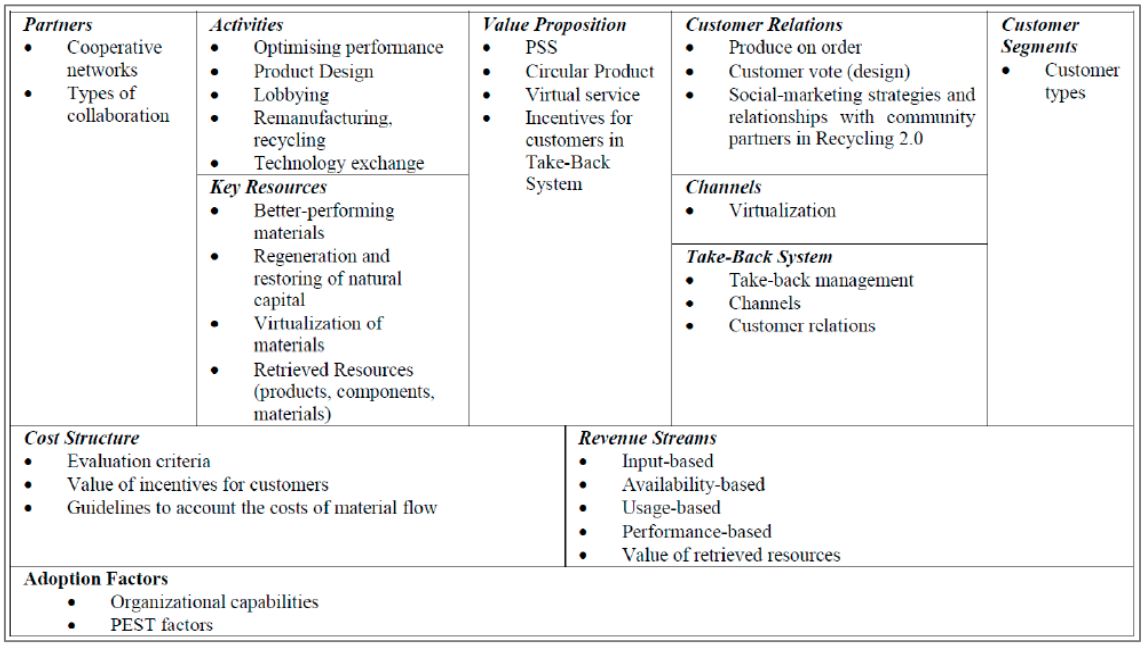

Figure 8. Framework for circular business model canvas. Source: Lewandowski.

So, in this part of the research, the circular business model will be used to evaluate a proposition for retail food waste prevention that includes a new form of treating retail food waste and collaborations between different stakeholders. The role of each actor (human or non-human) will be pre-defined thanks to the ANT analysis.

Methodology

To answer the research questions, multiple qualitative methods are used. The methods utilized in this semester report included literature review and interviews, which are presented in the following subsections.

Literature review

Literature review is critical for all research projects, and the first step to achieve major contributions to the research process (Colombo de Moraes et al., 2020). It is a form of qualitative research in which documents are studied, interpreted, and analysed by the researcher to map and assess the research are, motivating the aim of the study and ultimately justifying the research question (Snyder, 2019).

Initial search of documentation intended to collect data from food supply chain, food waste and food waste prevention. In this sense, research articles and directives and government publications (for food waste reduction) were mostly used. Search terminology included phrases like: '*Food waste Denmark'*, '*retail food waste'*, '*zero food waste'*, etc.

A second search phase intended to collect data food waste related to the retail sector and state of the art prevention solutions. In this phase, further research articles, food waste initiatives' websites and corporate (retailers) data on food waste avoidance strategies were studied.

The following table includes a selection of relevant material:

Table 2. Selected documents of the literature review process. Source: author.

Document	Objective
Waste – Uncovering the Global Food Scandal	Exploring the global food waste situation
UNEP Food Waste Report 2021	Exploring the global food waste situation
Bornholm showing the way - without waste 2032	Explore Bornholm's zero waste strategy for 2032
Addressing food waste reduction in Denmark	Acknowledge the food waste situation in Denmark
Retail food waste: mapping causes and reduction practices	Studying causes and characteristics of retail food waste
Opgørelse af organisk affald i servicesektoren – Bornholms Kommune	Quantifying retail food waste in Bornholm
Stop Wasting Food website	Studying the largest food waste prevention initiative in Denmark
Food waste avoidance initiatives in Danish food retail	Checking specific initiatives from retail sector to prevent waste

This selection of documents, together with the rest that were used in the production of this report, can be found in the references.

Natural Observation

During the 5-month research period, living and working for the waste management entity on the island provided several moments of natural observation. First and most primarily, from the

day-to-day work of the waste management plant, the routine with deliveries from private and commercial waste (which includes retail food waste), and how every data is recorded, though in a bulk manner (for retail food waste, in a way it is currently not possible to exactly determine how much of the supermarket waste is food and how much is non-food).

Furthermore, visiting retailers during free time, and exploring the environment in Bornholm with regards to the food supply chain (which ranged from dumpsters of supermarkets, including the pickup and emptying from the waste transport companies, to events from the civil society organisations). Observations also focused on soon-to expire products in the stores, for example, on their positioning, labelling and discount levels).

Other observations came from social media and internet sources regarding local supermarkets and their interaction methods. The purpose of this method is to present the possibility of collecting observations, in a way that the research subject is less influenced by pre-existing theories (Bryman, 2012).

Interviews

Personal interviews are a commonly used source of information between an interviewer or interviewers and the interviewee. They are then processed by the interviewer to present the information and are generally more complete sources of information than questionnaires or written correspondence.

This method includes the personal experience of the interviewee as a source for the analysis, which is convenient to the object of study, since the report takes the participation in a specific project as the point of departure.

Structured interviews

Structured interviews are used to standardise the asking of questions, to obtain a recording of answers and keep the interviewer related error to a minimum. Here, interviewers refrain from expressing views or opinions, and the room for informal talk is small. Interviewers should focus on their task (Bryman, 2012).

These interviews were a critical point for the whole study, to pinpoint the specific initiatives for food waste prevention in Denmark and also to map the possibilities for food waste transformation and prevention on Bornholm.

Semi-structured interviews

Semi-structured interviews present an interview with a specific set of questions similar to a structured interview, but in this case the interviewer can vary its sequence and has an extra option to ask further questions in response to the different replies that he/she is obtaining from the interviewee (Bryman, 2012).

At the second phase of the report's elaboration, and with the aim of understanding the plan, ideas, and other factors regarding future solutions for retail food waste on Bornholm, interviews were held under a semi-structured style, in which a part of the information that was sought was the opinion on the viability of different food waste treatment options.

As this information was not quantitative either a matter of yes or no, and more of a professional opinion based on experience a technical/economic knowledge, this part of the research was performed with semi-structured interviews.

Questionnaire

A questionnaire is a research instrument that consists of a series of questions, for the purpose of gathering information from respondents. This way of gathering information is useful when the researcher is seeking answers from a larger group and are very common method to generate data of trends or other statistics (Kabir, 2016).

The questionnaire in this project, is used to collect data on food waste habits at the consumer level, as well as their relationship with retail stores on the topic of engagement for food waste prevention initiatives.

Online questionnaires with 9 questions were distributed, with multiple choice options. These results are then collected and presented in the actor network theory analysis.

State of the art

As previously mentioned, the retail sector in Denmark is the 2nd food waste producer by quantity, with 24% of the total (being households the first food waste producer). This sector awakes a special interest, as most of the food discarded here is still edible for human condition. These products are discarded for economic or aesthetic reasons, or due to legislation: their proximity to the 'best before' date, fact that causes misunderstandings within consumers (Halloran et al., 2014).

Wholesale and grocery retail are mainly dominated by Coop Denmark, Dansk Supermarked Gruppen and Dagrofa, which control around 87% of the country's grocery turnover (Halloran et al., 2014).

In terms of legislation, the main goal is that set by the European Commission, to halve food waste per capita in 2030, in line with the SDG's (EU actions against food waste - Food Safety - European Commission, n.d.). In addition, by 2025 the European legislation will require recycling 55% of municipal waste, which includes retail and hospitality waste. This value is set to increase by 60% in 2030, and 65% in 2035 (European Commission, 2018). It is up to every member state to pursue this accomplishment by any means considered, including Denmark. At the same, the Commission recognised a lack of knowledge on food waste is a major barrier to create future solutions (EC, 2010).

So, Denmark has currently no national plan for food waste, besides the recycling of 50% of household waste in 2022 and committing to the goals set by European legislation. Current and most popular solution to process food waste is that of incineration for energy recovery, as a form of industrial symbiosis. Some retail and wholesalers have agreements with their private waste transport companies to deliver this waste to an incineration facility, for which the local governments are responsible for (Halloran et al., 2014).

This brings a situation where food waste prevention measures depend exclusively on initiatives out of free will, whether they originated from private or public sectors. However, there is a high number of initiatives on the national level, which are classified and detailed hereunder:

Private initiatives in Denmark

The first and main food waste prevention actions began generally as consumer movements, led by *Stop Spild af Mad* (Stop Food Waste), organisation founded in 2008.

This entity is now an association that works on food waste prevention across the entire value cain via information, dissemination, partnership, think tank activities, and so on. This movement has had a notable impact, which include a massive media coverage on food waste, established collaborations with retail chains such as Aldi, REMA 1000 or Coop and participated at dissemination events endorsed by the Danish government, the EU, or the UN (Danmarks størstebevægelse mod madspild, n.d.).

Thanks to this, the movement counts with a network of volunteer-run hubs (including two in Bornholm, located in Rønne and Nexø), in which arrangements are made with supermarkets to donate food that is close to its best-before date and the organisation give this food away to people in need.

An estimated 319 tonnes of food have been saved since 2011 with this initiative, collected and distributed in Denmark to charities and vulnerable people (Overskudsmad, n.d.).

Another organisation working in the country's capital city is Foodsharing Copenhagen. A volunteer-run entity, different supermarkets collaborate with the volunteers, donating surplus food that is then sorted and given away in different locations within the city. They also raise awareness via marketing and social media, and only in 2019 saved more than 13.000 tonnes of food (Story - Foodsharing Copenhagen, n.d.).

Further, an innovative business model has sprouted as a food waste prevention method in the last 5 years. It is the app TooGoodToGo, which connects users with local stores (retail and hospitality sector) that are selling surplus edible food close to its expiration date and would presumably end up as waste by the end of the day. Their numbers account for 35,9 million users of the app and estimate 68,7 million meals have been saved since 2016, both worldwide (Too Good To Go, n.d.). With an online platform, the entity also does dissemination on food waste prevention measures via different media, campaigns, and blogging.

Another original initiative is the one presented by wefood, a group of retail stores present in Copenhagen, Vejle and Aarhus. Wefood sells items that have a damaged packaging, incorrect labelling or expired "best before" dates that otherwise would be thrown away. These products are stille edible and safe, according to the food legislation (Wefood er DK's første butikskæde med overskudsmad og -varer. Kig forbi og bliv overrasket!, n.d.). Supply for Wefood stores comes from some distribution centres belonging to the main supermarket chains such as føtex (Petersen, 2021).

Figure 9. REMA 1000's food waste prevention homepage. Source: Sammen I kampen.

There has been an echo effect in the industry, and many retailers and other actors on the value chain promote food waste prevention via different initiatives. The danish retail food market is characterised by a high market concentration among retailers, each of them considering and performing different food waste avoidance initiatives (Kulikovskaja and Aschemann-Witzel, 2016). A list of several relevant ones is included hereunder:

- REMA 1000 ended its multi-item price on several products (for example, the get 3 pay 2) and came up with smaller sizes for some products such as bread packages and collaborate with Stop Spild af Mad (Sammen I kampen, n.d.).
- Coop was the first retail group that officially announced targets on food waste reduction. They committed in 2013 to reduce 10% food waste in 2013 and 2014 (compared to 2012) by different means such as reduced price on close to best-before items, signing a manifesto with Stop Spild af Mad for this purpose (Coop, 2013) and has since adopted other measures that include recycling hardened rye bread into rye chips, cooperating with food banks or selling greens by the item (Madspild a, n.d.).
- Arla Foods, Denmark's largest diary producer, has committed to reduce food waste in their production by 50% in 2030 compared to 2015 levels (Madspild b, n.d.), and carry out further measures focused on consumer behaviour. This includes dissemination articles on food waste prevention and good practices.
- Aldi has taken part in collaborations with civil society organisations to donate food to vulnerable citizens in the Randers area. Approximately, the retail chain supplied ca. 100 kg of excess groceries and vegetables (Kulikovskaja and Aschemann-Witzel, 2016).

More specifically, all the food waste avoidance initiatives coming from retailers in Denmark are mapped in the next table, classified by type:

Table 3. Food waste avoidance initiatives by Danish food retail groups. Source: Kulikovskaja and Aschemann-Witzel.

Initiative type	Initiative name	Aldi	Lidl	Coop	Dagrofa	Dansk Supermarked	Løvbjerg	Reitan Group
Product-related	Development of products otherwise wasted in the supply chain (e.g. bended carrots)							
	Development of packaging to reduce food waste							
Price-related	Reduction on food items close to expiry							
	Abolishment of multi-item offers							
	Implementation of a special offer concept 'Forlæng dit tilbud' (Extend your offer)							
Unit-related	Selection of food items in small packages							
	Selection of food items in packages that contain several separate units							
	Weighing selected food items							
Communication	Communication about the topic of food waste outside the Point of Sale							
	Development of digital application to communicate about the topic of food waste avoidance, food storage, etc.							
	Promotion campaign for suboptimal foods							
Collaboration and expansion	Collaboration with NGOs or other organisations							
	Partnership with an alternative retail store to sell suboptimal food items							
	Reuse of food items close to expiration date for new applications							
Instore-related	Implementation of technology to improve storage facilities							
	Day-to-day order-planning based on customer demand							

Finally, the Danish Consumer Council has also developed an awareness raising campaign to promote good practices to avoid food waste that includes dissemination media such as articles or a smartphone app. Their actions, however, are focused on food waste prevention practices within the household and thus after the retail phase (Madspild c, n.d.).

Public initiatives in Denmark

In terms of public-driven initiatives, there is a variety of them, which include stakeholder conference meeting connecting public and private stakeholders, public talks on the subject at events such as the *folkemødet* and several studies on food waste in Denmark.

More specifically, these studies focus on raising awareness among consumers and highlighting food waste reduction trends and are carried out by entities ranging from Danish Universities to the Danish Environmental Protection Agency. The Ministry for Food, Land Use and the Ministry of Environment are usually dissemination this information.

Figure 10. Food waste debate at Folkemodet 2014. Participating: Connie Hedegaard, EU Climate Commissioner; Christine Antorini, Social Democrats; Adam Price, author and TV host; John Wagner, director at De Samvirkende Købmænd, Selina Juul, Stop Spild af Mad. Source: Stop Spild af Mad.

According to their government, their aim is to have avoidable food waste reduced all along the food product value chain. Currently, the government's role is to encourage food waste reduction and monitor the developments (Ministry of Environment of Denmark, 2015).

MAIN TAKEAWAYS – STATE OF THE ART

- Main legislation set by the EC is to halve food waste per capita in 2030, which follows SDG 12.3.
- In Denmark, there is currently no national plan that tackles this problem directly.
- There are a number of privately driven initiatives to prevent food waste: Stop Spild Af Mad, Foodsharing Copenhagen, TooGoodToGo, Wefood, ARLA or REMA 1000's strategies, among other.
- Publicly driven initiatives include stakeholder meetings, conferences between public and private entities (in events like *folkemødet*) and University studies.

Analysis

At this point, the research is focused on understanding the actors that are involved in the retail food waste stream in Bornholm to find a new solution or set of solutions that could eventually help prevent the amount of retail food waste (under 515.000 kilos, according to Econet) on the island.

First, a mapping of all relevant actors in the retail food sector will be carried out. The idea is to set a clear picture of who is doing what on the supply chain, and what can be applied or improved on Bornholm. This will be done via natural observation and interviews with relevant actors. The goal is to ultimately understand the roles and motivations on food waste prevention of these different actors.

What is the role of each actor in the supply chain? Which of them have more interest in food waste prevention measures? Can they come up with a common solution? These are the questions seeking response. BOFA, both as waste management entity and local authority, has prevention as its priority regarding waste, and is ready to support and co-develop local measures in this regard, beyond their regular capabilities (BOFA, 2019). So, ideally, the public company could lead or facilitate actions for prevention.

Collaborations will be sought in this direction. Research also appears to back this up, as to transition to circular economy and sustainability, collaborations and new partnerships are one of the key aspects to cover (Gray and Stites, 2013). Once most relevant actors involved on retail food waste on the island are identified, together with their interests, the Business Model Canvas applied to circular economy will be used, setting a common ground with the actors most interested in prevention measures, to analyse the potential of such initiatives on the island. An exemplary action that comply with this framework will be suggested, as a final result.

Actor Network Theory

At this point of the research, the first interpretation of the data obtained through interviews and observation is to convey the status of retail food waste on Bornholm. This implies creating a scenario in which all actors, and their interrelations or processes are portrayed, through the Actor Network Theory.

So, the initial step in this analysis is to interpret the different elements in the retail food waste system, in human and non-human elements, and their relations, as they each participate and interact in a collective action (Callon, 2001). This data is gathered in the following table, using natural observation during the 5-month research period:

Table 4. Human and non-human elements of the food waste supply chain in Bornholm. Source: author.

Element	Classification
Waste Management Entity	Human
Retailers	Human
Food Suppliers	Human
Civil Society organisations	Human
Food	Non-human
Food waste	Non-human
Waste Containers	Non-human
Waste Transporters	Non-human*
Biogas producer	Human
Consumers	Human
Business (service) based on food waste	Non-human**

*Waste Transporters are included under Non-human, as the focus is on the transportation process itself, this is, moving waste from point A to B.

**Business based on food waste responds here to an app service, such as TooGoodToGo, hence, it serves as a technological tool.

Hereunder, the main different actors are explained, including identification of their links and relationships between one another.

Waste Management Entity

BOFA, the waste management on the island of Bornholm, is the public company that runs the incineration plant at their main site just outside of Rønne, plus 6 other locations which run primarily as recycling sites in which citizens and companies visit to sort their waste, except for the one at Vestermarie, which works a recycling centre.

BOFA receives food waste from supermarkets mixed with other types of waste (that can vary from disposable facemasks to cardboard or glass, among other), this waste is thrown away in the pile for incineration after being weighed.

In this sense, BOFA has no direct contact with supermarkets regarding their waste, nor has the obligation to require anything from supermarkets, and this matter is apparently not on the table right now:

"And so that would mean for a supermarket, for instance, they would solve that food waste out and of course, it would still be in packaging […] with Lennart Ipsen or someone else taken to the biogas plant, put in this new separator […] So, in principle, BOFA will not be involved actually until the reject comes here if we're talking about waste from a supermarket."

(Hjul-Nielsen, 2021)

Though there are no collaboration with supermarkets, BOFA is not reluctant, however, to different collaborations with different partners. In fact, the waste management entity has been working on new forms of collaboration to prevent waste for the 2032 vision. More specifically, partnerships have been created with two local sports associations, Hasle Sport Association (HIF) and Aakirkeby Sports Association (AAIF) (Christensen, Hjul-Nielsen, Moalem and Johansen, 2020). Though not attaining food waste, this can serve as an example of out-of-the-ordinary collaborations from the perspective of a waste management entity.

Another (potential) collaboration is that of BOFA with the biogas plant, Bornholms Bioenergi. In the coming months, with the entry into force of household waste separation in 10 fractions

starting 1st of January 2022, organic waste is intended to be processed for biogas production at a plant, and Bornholms Bioenergi is the only one on the island.

"What we are waiting for now is the procurement, for the food waste. Because it will start in January next year, right? […] From the first of January 2022, the households are going to collect all the food waste and the first of January 2023, all the retailers have to collect the food waste as well."

(Koefoed, 2021)

The entry into force of this measures implies that the food waste (organic fraction) will be treated for energy extraction at a biogas plant as a primary option.

In terms of engagement with consumers, BOFA communicates mainly via their facebook page, as well as via other means, especially meetings/events with schools, or CSOs/citizens in light of a specific event, for example, the participation of BOFA in international projects, as it has been seen in the past.

Retailers

Retailers on the island include 29 supermarkets stores (Netto, Fakta, Lild, Super and Dagli Brugsen, REMA 1000, SPAR, Meny and Kvickly), plus a wholesaler (DAGROFA), which is a slightly different category, as it works on a business-to-business basis supplying produce to the service sector and not to the final consumers (Svendsen, 2021).

Some of them (REMA 1000, Fakta, Netto and Kvickly), do have collaborations with CSO's on the island, such as Stop Madspild Lokalt. These collaborations come out of individual agreements between each donating store and the CSO. Though the partnerships are individual, the general vision of participating retailers comes from upper management or Corporate Social Responsibility:

"- So it's both an economic interest I have, but also its more like social, we want to make a difference in our social in our local environment, and it's a big part of REMA's social responsibility.

- And, REMA's social responsibility, is it Bornholm or it also comes from the upper part of the organisation?

> *- From up, we've been told to make these deals with, for example, Stop Madspild Lokalt. And if we do not have an agreement with someone, they'll find something for us."*

(Niclas, 2021)

In terms of interaction with consumers, few of them offer online platforms on the island. REMA 1000 Gartnervangen in Rønne does have a facebook page in which they offer information such as offers on fresh products, opening hours on special days or other miscellaneous information related with the store's day-to-day work. In this sense, there is a wish from the store to use it further, which would potentially generate more engagement (Niclas, 2021).

In this context, a supermarket such as wefood, which runs as an NGO under the premise of fighting food waste (Petersen, 2021), actively engages with consumers via their facebook page. This can strengthen the idea that engagement via social media is one of the tools to fight food

waste, perhaps, focused on a younger generation which is more used to this means of interaction.

Speaking of food waste, this is generated by supermarkets as a consequence of poor demand forecast and inventory management. Other reasons include disposal of unsold food or when food has reached its best before date (Despoudi, 2019).

Regarding the retailer's relation with the waste transport companies, it is based on the service the waste transport company offers (pickup and emptying of containers, emptying them of waste) and this service is more expensive if there is a bigger amount of waste to be transported:

"- Ok, so how does it work with a waste transport company? They offer you the service of waste pickup, do they charge you then depending on the amount of waste you give them, in weight?

- Yes, exactly.

- Ok, so the food you deflect from throwing it into the container is money you save?

- Exactly."

(Niclas, 2021)

Hence, it is safe to conclude that it is in the retailers' best interest to minimize food waste as possible, in two ways: first, in the fact that food thrown away is food that has been paid for yet unsold, and secondly, in the fact that the more food is deflected from the dumpster, the cheaper the waste transport service will be.

Regarding the retailers' relation with the waste management company, BOFA, there is no direct link following the conventional food waste stream (besides the fact that the waste transport company deliver the supermarket waste to BOFA). Nonetheless, it appears there has been some conversation regarding other initiatives:

"BOFA actually contacted me wanting because they want to make this a fruit and vegetables bag that could make the fruit and vegetables last longer. Yeah, and they wanted to make it a part of our stores here. And they wanted to start it as an experiment for only these two REMA 1000."

(Niclas, 2021)

So, it is arguable to think that BOFA is willing to do some out-of-the-box thinking and trial some new form of partnerships with the aim of reducing food waste in innovative waste.

Civil society organizations

This group includes entities such as Stop Madspild Lokalt or other volunteer-run entities that are related to the food supply chain in one or different ways.

These organisations are based on volunteer work, so usually these workers share the organisation's vision and enjoy carrying it out (Petersen, 2021). In Bornholm, this is represented, within the retail food sector, by Stop Madspild Lokalt. Their form of collaboration with other actors (retail and wholesalers) is in the form of agreements that do not involve economic activities but food donations.

"*We have an agreement with a little organization called Stop Madspild Lokalt. And they come two or three times a week at DAGROFA. And then we give them the food on the day as on the best before date. The exact date, not the day after that*."

(Svendsen, 2021)

The agreements with retailers (and one wholesaler, DAGROFA) are carried out individually, without an economic incentive and one by one with each supermarket and are written on paper, whereas with other actors such as the hospital (where some workers inform on vulnerable people that just came out of treatment and volunteers bring them food) there are non-written agreements (Zarp, 2021). These agreements also include a health regulation condition:

"There is one collaboration contract that each supermarket agrees to with the organization. The shops make an inventory of food close to the best before date, guaranteeing its storage does not break the cold cycle (food is kept between -18ºC and 5ºC)."

(Zarp, 2021)

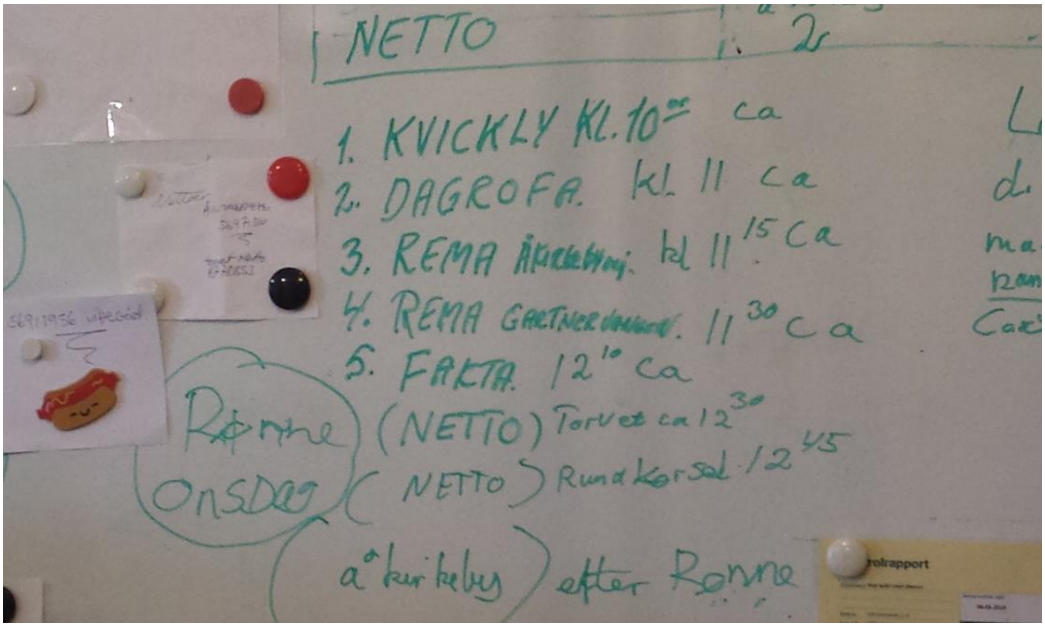

Figure 11. Stop Madspild Lokalt's pickup itinerary in the Rønne office. Source: author.

This CSO works in a way volunteers pick up food from the supermarkets that donate it on a 3-day weekly basis (Mondays, Wednesdays, and Fridays). Food is picked up under a defined schedule between 10:00 and 13:00 and then sorted and given out at the CSO's locations in Rønne and Nexø between 15:00 and 16:00. Stop Madspild Lokalt has donation agreements with 7 stores in the retail and wholesale sectors: 1 Kvickly, 2 REMA 1000, 2 NETTOs, 1 Fakta and Dagrofa (Zarp, 2021).

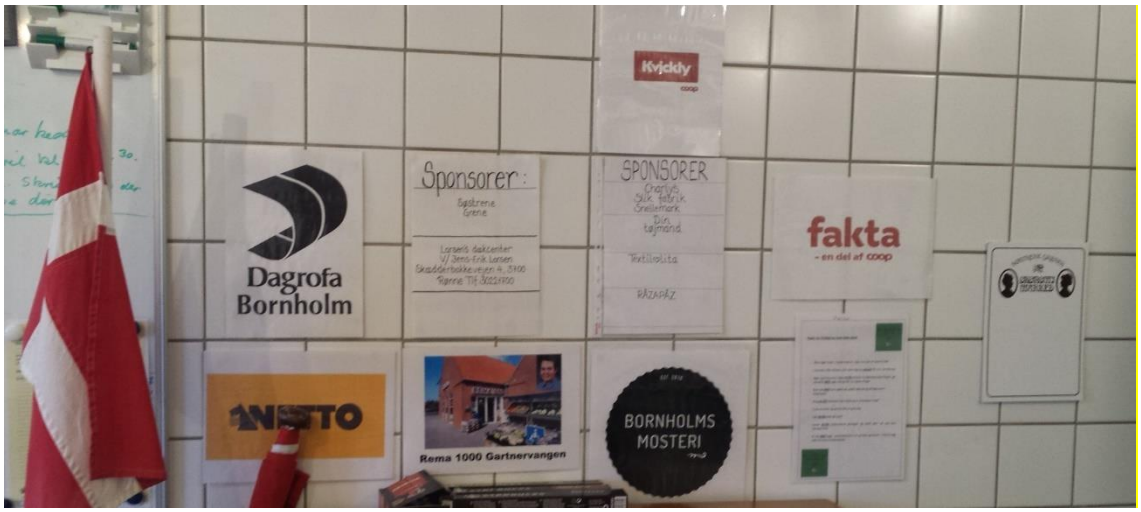

Figure 12. Stop Madspild Lokalt's main sponsors at their Rønne office. Source: author.

Main engagement from this entity with consumers is carried out via Facebook. This matches, too, the way of reaching out to consumers of another CSO (specifically, working as a NGO) like Wefood with shops in other parts of Denmark (Petersen, 2021).

Wefood, as previously described, runs its stores by volunteers but still has an economic activity that includes fixed costs such as the store rent, electricity bills, etc.; and thus, needs to generate a monetary income. Both entities are, however, based on the common principle of fighting food waste and so their volunteers may have similar motivations of those at Stop Madspild Lokalt:

"*pick out the one the bad one and then we could sell the rest of the package for a very low cost. And this is something that our volunteers really enjoy.*"

(Petersen, 2021)

In this regard, a civil society organisation based on an economic activity (like Wefood's model), seems unlikely to work in Bornholm due to its lack of targeting a critical mass and complex logistics that can make the business reach a break-even point:

"*We have to at least have around 40 volunteers to you know, to run the shop […] we can take an example, we can go out to the north of Jutland then […] get 40 volunteers but the population density is not that big so it wouldn't make sense […] the logistics in Bornholm it's […] just a hell, sorry. It's very costly to transport the goods to Bornholm."*

(Petersen, 2021)

However, there appears to be a potential of improving the activities of a volunteer based CSO to fight food waste on the island, such as Stop Madspild Lokalt, according to a more professionalized food waste prevention entity such as Wefood:

"It would really had to be a local you know, driven concept in Bornholm. All the local producers came together and say "okay, we want to help them the cause in Bornholm" […] Stop Madspild Lokalt which is very local. And they only have to fight food waste, it doesn't have to make any profit. It's only because of fighting food waste. Then then it could be you know, another kind of concept than Wefood for instance."

(Petersen, 2021)

CSO's in the island appear to have a special relevance if compared to mainland Denmark, especially due to the fact that Stop Madspild Lokalt acts on a basis (avoiding food waste) that is aligned with the island's zero-waste 2032 vision, on the first level of the waste pyramid: prevention.

Waste Transporters and waste containers

Waste containers, containing food and non-food products, are located outside the supermarkets and picked up on site by the transport company (Marius Pedersen or Lennart Ipsen). Supermarkets employees fill these up with waste (food and non-food), whilst the transportes empties them on site, moving the waste into their trucks, and places the empty containers on the same collection spot.

The waste transport entity's role is thus to pick up waste from their clients to the waste management plants, for it to be processed. The company charges for their service according to the weight of the pickups, hence, it is economically beneficial for retailers to waste less (Niclas, 2021).

Food and food waste

This is the main subject of the research. Food is the reason why retailers exist, why consumers visit the supermarkets and a fraction (organic waste) which has a potential for further treatments (such as energy recovery), due to its chemical energy content. Food is hence an actor around which a network is built upon.

The amount of food waste from retailers on the island, is estimated on 515.000 kg every year (Econet, 2017). This amount includes packaging and may or may not include food still fit for consumption. The current plan is to depart from incineration treatment at BOFA, to a biogasification process for further energy recovery (as the incineration plant will close no later than 2032) at a plant that has the capacity for it.

However, the treatment is not the best environmentally terms, as there is still a combustion involved with its consequent CO_2 emissions. Recalling the waste management hierarchy once more, prevention is the first option, whilst other recovery, including energy one, is at a fourth level, after prevention, reuse and recycling (BOFA, 2019).

A critical factor for food waste prevention appears to be initial separation at the retail stores. Once food waste is thrown into a container, it is treated as waste, together with other non-food elements, and it offers no health guarantees as the cold chain might break after some time.

Furthermore, food poisoning is a high risk for retailers and food manufactures, as one single case and its media coverage could cause sales of a particular product to drop drastically. In this sense, it is believed manufacturers and retailers that determine shelf-life allow huge margins of error to determine when a product will start to go off, not rather on the side of security, but for commercial reasons (Stuart, 2009).

This is supported by wholesalers and retailers, their main reason for throwing away food is its arrival to the best-before or use-by date.

"*Yes, our main food waste would be due to the best before date.*"

(Svendsen, 2021)

Currently, the food that is saved by Stop Madspild Lokalt is given out as latest on the same day as its best-before one.

"Any food is given away as long as it is still under the best before date, as otherwise it would be illegal"

(Zarp, 2021)

Food that is one day past this date will automatically be discarded into the containers, to be picked up by the waste transport company and delivered to BOFA for incineration.

Biogas Producer

There is one biogas plant on the island, Bornholms Bioenergi, that generates heat and electrical energy, thanks to the processing of organic waste. This does not include all organic waste (excluding, for example, bones), as it must have a particular texture that allows it to be pumped.

Hence, waste comes from farms, slaughterhouses, and breweries on the island and recently from a local hotel, which has purchased the grinding machine to make this waste apt for the pumping system. This means, food waste from retailers will also have to be separated from its packaging and treated, if this is the direction that will be taken (Koefoed, 2021).

The basic operation of a biogas power plant is based on the process of fermentation of biomass, that thanks to its methane content, which is then combusted, transforming the biogas' chemical energy into heat and electrical energy. Classic biomass matter supplied to these plants include slurry, fats, agro-industrial leftover products and agricultural products (How does a biogas plant work?, n.d.).

The island's biogas plant works with two gas combustion engines, which generate a total electrical power of 3 MW (Koefoed, 2021). So, this entity serves as a particular nexus for the food and energy sectors, which, together with water and their management, call out for attention to their complex interactions for a proper development progress (Leck, Conway, Bradshaw and Rees, 2015). In this case, the biogas producer's interest would potentially be to continue and expand operation, including food waste, to generate energy security, on the risk of undermining food security.

As previously mentioned, when describing the waste management entity, the island is going to undergo a drastic change on household organic waste collection in the next months, followed by retail organic waste on the following year. Hence, the primary option is going to be for this fraction to be treated for biogas production. The existing biogas plant is designed to further treat the extra capacity required for these fractions.

"- Would this plant have the capacity to treat an extra 520000 kilos each year, so 500 tons extra each year?

- It is it is designed for this. Yeah."

(Koefoed, 2021)

The possibility of extracting energy from food waste is plausible in Bornholm Bioenergi, as one of the conditions for biological treatment is that the facility can handle packaged food (Halloran et al., 2014).

"I don't think the supermarkets should do the separation, because I cannot control every load I get from them, but I think they should come with it. So, this plant, we do the separation […] I can do the separation, because then I know the quality. And I have the set up to do the separation."

(Koefoed, 2021)

Consumer

Consumers are the final link on the food supply chain, and those who visit supermarkets to purchase their food for consumption generally do so searching for different motivations: efficiency and convenience, low prices, social contacts, experiential experiences, large assortments for one stop shopping, fresh and pre-packed foods, techniques that reduce shopping time, friendly and knowledgeable personnel, a seductive shopping atmosphere and promotions and demonstrations, among other (Geuens, Brengman and S'Jegers, 2001).

In order to map their relations more specifically, behaviour and opinions regarding food waste at the retail level, an online questionnaire was carried out among individuals living in Bornholm, with the following questions (following a multiple-choice format):

Table 5. Questionnaire sent to citizens in Bornholm. Source: author.

Question	Answer options
Please select your age group	• 18 – 25 • 26 – 45 • 46 – 65 • > 65
Is food waste a concern for you?	• Yes, I try it to avoid it at the household • Not really • Other
Do you throw away food at home, that may be suitable for consumption (for example, an apple that's a little wrinkly, bread that is in the process of hardening)?	• Yes, quite oftenly (around once a week or more) • Not really (perhaps once or twice a month a month) • Almost never (maybe once or twice a year)
Do you throw away food, just when it's "best before" has arrived?	• Yes, as soon as it reaches the date and mostly without checking it's state. • It depends, I first check it's state, if it looks good, I'll still eat it. • No, I don't really look at the best before date. • Other
Are you comfortable with buying close to best-before food products at a discount?	• Yes, not a problem • No, I have some issues with that • Other •
If you have food close to best before date, do you cook/process food to prevent it being wasted? (for example, baking banana bread from mature bananas, making breadcrumbs for old bread, using the freezer, batch cooking, etc)	• Yes • Sometimes I do, sometimes I end up throwing food • No
Do you think there is enough information about food waste prevention measures?	• Yes, consumer awareness is high • No, their is potential to increase consumer awareness • Other
Could your food waste prevention habits be improved, if your local	• Yes, potentially, I can be engaged by campaigning

supermarket/grocery store offered further information about waste prevention measures/habits?	• It depends • Not really, I go to the store just to buy the food and nothing more
How would your preferred means of communication with supermarkets, on the topic of food waste, be?	• Posters at the stores • Social media posts and digital campaigns • Printed materials at the stores • Other
Have you heard of any activities or organisations on the island, to prevent food waste?	• Yes • No • Other
Do you think cooperative events, between civil society organisations, supermarkets and the local governments on the topic of food waste prevention could be successful in your local community in Bornholm?	• Yes, there is potential • No • Other

The questionnaire aimed at mapping behaviours and concerns from a general point of view (awareness on food waste) to a particular one (consumers' ideas on activities to prevent food waste and relationship with retailers), going through areas in the middle such as waste prevention habits in the household.

Some results appear to contradict each other somehow, specifically regarding the best before date. Only 5% admitted food is thrown away just when the best before date has arrived (hence, at the household), yet 28% admitted having some issues or other unfavourable responses when buying best before food on discount, at the retail store. This may relate to previous research on this subject, as Danish consumers appear to be uncertain on how to read and interpret the best before dates, throwing away food with uncertainty if it is safe or not to eat (Halloran et al., 2014). Globally, this is also backed up, as the best before date is a matter of confusion for consumers worldwide, resulting in food disposal that would still be apt for human consumption (Colombo de Moraes et al., 2020).

Now, further answers build upon the idea that consumers are not fully aware of specific food waste prevention measures. Though 83% of participants agree that food waste is a concern for them, just above half of them (54%) positively answered that they process food by different means, to prevent its waste at the household level. This is backed up by a majority (64%) answering that there is not enough information available on food waste prevention, meaning there is a major problem to address at the consumer level, too.

In terms of engagement and means of communication with the retailers, 36% of consumers agreed their food waste prevention habits could improve if local supermarkets offered information on this subject, with 38% answering maybe, and 26% agreeing they only go to the shop to buy and are not engaged by campaigning. For communication, 54% of participants agreed on social and digital media posts being their preferred means of engagement from supermarkets, whilst 26% responded being posters at the stores.

60% of participants have heard of food waste prevention initiatives on the island (mainly Stop Madspild Lokalt), and a majority of 91% answered positively to the question "Do you think cooperative events, between civil society organisations, supermarkets and the local governments on the topic of food waste prevention could be successful in your local community in Bornholm?"

After these considerations, it is logic to think that there is a potential to increase not only awareness but collaborative or engagement initiatives that can further minimise food waste on Bornholm. The actors involved in food waste are numerous and perhaps, one of the reasons why food waste is generated may be their different roles and responsibilities within the food supply chain.

This is also aligned with implementation actions to prevent food waste promoted by the EU, which promotes the creation of Multi-stakeholder platforms to spread knowledge, find solutions and join efforts to support food waste prevention (Recommendations for Action in Food Waste Prevention, 2019).

At an operational level, one of the factors that act as a barrier for these prevention solutions can be the current disposal of food waste by retailers, as it is thrown away in the same containers as other non-food waste. This is partially going to change, with the entry into force of the organic fraction for its biogasification processing.

However, food waste existing initiatives such as TooGoodToGo are possible thanks to a separation at the retail level of soon to reach the best before date on products. An option is thus to seek for a better model that can stem from this principle. This option is also supported by the EU, which also promotes cross-sectorial collaboration for the scaling up of initiatives that have impact on food waste prevention (Recommendations for Action in Food Waste Prevention, 2019).

So, the research leads to describing a plausible solution, based on a multi-stakeholder scenario on Bornholm and its associated business model.

MAIN TAKEAWAYS – ANALYSIS: ACTOR NETWORK THEORY

- The retail food waste supply chain involves many actors with various particular interests.
- There are some prevention solutions in Denmark (for example, Wefood), that are not applicable on Bornholm due to its population and geographical particularities.
- The actors with more interest on retail food waste prevention appear to be: Stop Madspild Lokalt, retailers, the waste management authority and consumers.

Business Model Canvas

At this point, reflecting on the different actors and taking the island as a continuously developing arena for the interactions (Aka, 2019) a business model canvas for the case of food waste prevention in Bornholm will be explored. Few business activities pertaining to circular economy have been identified in literature, yet the circular economy business model developed by Lewandowski, the developed conceptual framework identifies circular economy principles applicable to every generic case. In light of the different interests and roles of relevant actors on food waste on the island, it seems evident that there is a need for new collaborations or partnerships between them to transition to a more circular food system.

In line with this, and as the research is focused on the island and its network of actors on retail food waste, the case is built not upon a particular company, but upon the entire network, which seems convenient as the business model canvas applied to circularity aims to contribute to the discussion on circular economy and its implementation and providing a tool for practitioners on the micro-level (Lewandowski, 2016). This will aim at creating a community consciousness on food waste prevention habits and solutions, with a focus on the value that soon to best before date food (or other food discarded by supermarkets still apt for human consumption) with the ultimate goal of preventing it from being waste. A tentative title for the specific Circular Business Model Canvas to develop can be: "Food Waste Prevention Bornholm – a network of opportunities".

As a limitation to the applicability of the framework, the fields of Cost Structure and Revenue Streams have been omitted. The reason to this relies on the facts that both concepts are unavoidably linked to how a product or company makes sales and generates profit. Revenue streams are generally defined as how a business makes money, and the number of circular economy propositions associate with pay per product or service, which seems too far out of the research's scope. Similar principles apply to Revenue Streams, which is still very company-oriented, and there are still no good examples in the literature that enhance circular economy activities (Lewandowski, 2016).

First, the most evident opportunities and limitations drawn from the previous sections are gathered:

- The waste management entity has previously engaged on new types of collaboration and there is a concern on food waste:

  "We have a focus on this because one thing is the food itself […] There are technical solutions already. It's really only a question about if we're able to scale them down to our need."

  (Hjul Nielsen, 2021)
- From an economic perspective, it is beneficial for retailers to donate food rather than to dispose of it in the dumpster:

  "- Waste transport company, they offer you the service of waste pickup, do they charge you then depending on the amount of waste you give them, in weight?

  - Exactly.

  - So, the food you deflect from throwing it into the container is money you save? Exactly."

  (Niclas, 2021)

- Food waste in Denmark is largely or partially avoidable (Halloran et al., 2014). On Bornholm, retail food soon to reach its best before date is generally accepted (72 %) by consumers, yet, once its reaches this date, it is illegal to sell or donate (Møller et al., 2014).
- Consumers preferred means of engagement are social media posts and posters at the stores, with 80% of the participants of the questionnaire all together.
- From the consumers' opinion events, between civil society organisations, supermarkets and the local governments about food waste prevention have the potential to prevent food waste, with a big majority of participants agreeing on this (91%).
- Civil society organisations, specifically, Stop Madspild Lokalt, work on a scheduled and volunteer-based structure which currently count with ca. 14 of them (Zarp, 2021). There are, however, some supermarkets that do not collaborate with the entity (21 out of 27).

On the other hand, the business model canvas for circular economy includes the following main characteristics to favour circularity:

- Partners seek new ways of collaboration and cooperative networks;
- Activities should aim at optimising performance and remanufacturing;
- Key resources include the retrieving of resources;
- Value propositions should include virtual services and incentives for take-back systems;
- Customer relations should rely on consumer participation (codesign), social marketing strategies and relationships with community partners;
- Channels should be virtual;
- Cost structure should include an evaluation criteria, incentives for customers and guidelines to account for the material flow costs;
- Revenue streams should be performance and input based, and take into account the value of retrieved resources;
- Adoption factors for these models include organisational capabilities (Lewandowski, 2016).

From this point onwards, every section of the Circular Business Model Canvas is particularised to waste prevention possibilities on the island on Bornholm:

Partners and Activities

Here, it seems as including retailers, civil society organisations, the waste management company (also fitting in the role of local government entity as public company from the Municipality), and consumers is arguable as they all have a common interest, that of reducing food waste.

Biogas producers and waste transport entities, due to their business activity, do not have a specific interest on it, besides social corporate responsibility areas.

The question lies in which activity or activities can serve to create new cooperative structures. A nexus possibility could be the celebration of batch cooking events, where Stop Madspild Lokalt brought donated food to the different *forsamlingshuse* (community buildings, where neighbours gather and meet for community activities) in different villages of the island, or even outdoors at BOFA's main location in Rønne, to perform a demonstration cooking class, as the waste management entity counts both with a teacher in charge of education and public relations tasks and a qualified chef that also works as environmental worker.

Such an activity could bring these 4 actors around the concept of preventing food waste, create some awareness and give an answer to the consumers (100% of them think more local cooperation could be made in the matter of food waste).

A further activity, that can be in line with this event or independent, can be educational activities on food waste prevention practices, separated in age groups (for example, adults and children). In this sense, BOFA could rely on the existing collaboration with local schools and kindergartens, an have an informal setting, for example, at the water tower, where global facts on food waste could be presented. This fact also relies on organisational adaptation, which is one of the highlighted characteristics for achieving a circular business model (Lewandowski, 2016).

Key resources

The key resource for this model is food soon to reach its best before date. This food is used by Stop Madspild Lokalt, which approximately saves 100 kg food per month from coop retailers (Zarp, 2021) and an estimated 96 - 120 boxes of food per month from REMA 1000 (Niclas, 2021).

Considering that Stop Madspild Lokalt engages with 6 of the 27 supermarkets on the island (Zarp, 2021), there appears to be potential on food to be saved from other retailers, which presumably will throw away the unsold best-before date food to the dumpsters and then end up in the incinerator. The key resources here rely on better performance of the resources (to be eaten, when possible, rather than disposed of) and retrieving them from this disposal, which is aligned with Lewandoswki's conceptual framework for circular economy business model. This could be a lead, given that close to best before food is generally accepted, to further promote its sales in the stores or agreeing on its donation.

Value proposition

The concept of value proposition has evolved throughout the years. Nowadays, scoping to a long-term vision (such as 2032 zero-waste Bornholm), economic value has progressed into services and experience, rather than solely prioritising good and commodities. Especially experiences, they are emerging as the next step of what economists dub as "the progression of economic value" (Schmitt, 2010).

So, the value proposition in this research includes different aspects that rely on these considerations. There is, also, an economic benefit for retailers: donating food reduces costs, in the form of money that is saved on the waste transport service, and a social benefit: in terms of CSR, generating a more responsible image as the store can contribute to a social/environmental cause. A further strategy seeking economic savings, can be more aggressive discounts on best before products and the promotion of these discounts via posters on the stores or social media promotion. This will always be more economically beneficial than discarding it.

From the consumers perspective, an incentive for them can be that food (apt for consumption until its best before date) at a vert reduced price or donated. The question here is how to make this value proposition (initially based on economic savings) appealing, generating an experience that not only has environmental benefits but that the consumer enjoys.

Furthermore, research shows that education on food waste prevention, and further on the implications of food waste at economic, social and environmental levels is needed to trigger a transition (Despoudi, 2019). So, the value proposition for "Food Waste Prevention Bornholm – a network of opportunities" should blend education and economic aspects, through an experience that appeals to consumer senses, to be more effective.

Customer relations and channels

Customer relations for the circular business model canvas include the social-marketing strategies and relationships with community partners (Lewandowski, 2016). In this case, digital media (including social network platforms such as Instagram or Facebook) appears as the most popular means to engage with consumers, as well as in-store posters. This can be used for announcements of soon to reach best-before dates, or other food waste prevention tips and activities, among other.

With an effective use of these campaigns that appeal to emotions and at the same time transmit the environmental benefits of preventing food waste, there is a great potential impact in customers. This is based on the fact that consumers have evolved, seeking for marketing campaigns they can intimately relate to, those that present them with an experience (Schmitt, 2010).

At the same time, the Circular Business Model Canvas enhance consumers as having a vote for these solutions. This can be done through, the aforementioned social media posts, but also by the promotion of collaborative food waste prevention events (as suggested by consumers, who 100% agreed more could be done in this sense), or in a more digitalised manner, by the use of an app, for instance.

Including consumers in the design of solutions to handle waste is further aligned with some of BOFA's recent activities, for example, during the WASTEMAN interreg project in which BOFA significantly participated in a Living Lab activity with two of the local villages. In this context, it is sensible to say that users should participate to some extent in this solution/s, as in order to also design the waste system of the future, the overall culture of waste handling by citizens needs to be properly addressed (Jensen et al., 2019).

Take-Back System

In a circular economy, material loops are at the core. Now, for the Circular Business Model Canvas, take-back implies the use or reverse logistics, incentives on return, reuse or collection or used products which can be seen, for example, in how the bottle return system works in Denmark.

In the case of "Food Waste Prevention Bornholm – a network of opportunities", this system requires special considerations, as food is a perishable product that has to meet certain requirements for its consumption. One of the habits to depart from is minimising throwing food to the dumpster when it reaches the best before date by trying to educate and offer better discounts, among other, yet assuring the food is always still apt for consumption.

Hence, the Take-Back System is included on a subtle manner, where consumers would not return food to the supermarket but have broader knowledge on how to avoid its disposal. The point is to make an extra effort on preventing some retail food waste to end up at the Biogas Plant if it is still apt for consumption.

Customer segments

The Circular Business Model Canvas most importantly relies on the value proposition, which in this case builds around the value of food soon to be discarded by the supermarket, still as a valid option whose consumption prevents its environmental consequences, whilst meaning the end user also saves some money and learns on food waste prevention practices.

In the case of retail food waste prevention in Bornholm, the question to ask is: Who is benefiting from this proposition? The proposition here is not a specific product, but a service based on collaborative consumption, which can bring cost savings, environmentally friendly services and other additional services (Lewandowski, 2016). Though there is broad literature covering research on the type of retail shopper and their motivations, it seems as a self-limiting classification for the purpose of this research, as the goal is to make an entire community more aware of retail food waste and implementing measures to prevent it.

So, given this holistic perspective of the service (to be of use for the whole island of Bornholm), the customer segment can include here the whole community of retail customers on the island.

Adoption Factors

This sector of the Circular Business Model Canvas aims at how an organisation should adapt, to embrace a business model with circular economy principles, as working under a business-as-usual regime can result in rejection of circular business models (Lewandowski, 2016).

This includes both internal and external factors to the organisation/s. Internal factors are mainly organisational and role capabilities that aim at adapting towards circular economy principles and include organisational culture, knowledge sharing, transitioning procedures, etc. External factors include technological developments, sociocultural changes (such as shifts in customers habits), and political or economic aspects (Roos, 2014).

In the case of "Food Waste Prevention Bornholm – a network of opportunities", these should be identified and explored in different entities. Picking BOFA, this factor should enhance out-of-the-box thinking for innovation, in the form of a person or unit willing to sit down and discuss with internal and external actors' collaborations seeking an effective transition to circular economy. There are some indications that this entity is in the correct path to do so, for example, with their collaborations with local sports associations or initial conversations with supermarkets for the trial of grocery bags that extend vegetables' lifetime (Niclas, 2021).

Similar principles could be applied to other actors in the value chain, such as retailers. This could include a person which, within his/her responsibilities, has the specific role of engaging for food waste prevention initiatives on the island, and having to allocate some time every week to do so. There appears to be intentions from several retailers (mostly, those which collaborate with Stop Madspild Lokalt), but still there is not an organised role that describes this activity.

"- And to be honest, I want to use it [Facebook] a lot more than I'm doing, but it's like my energy source in the store and not online.

- So, you'd say that your job description does not include keeping up the store's social media strategy?

- Exactly."

A further role in this context could be having one person in staff that quantifies, labels and places in the store's discount area the food to be expired on the day, and publishes a social media post about it, at the beginning of the day.

Grouping these and other considerations in a Circular Business Model Canvas results in the following:

Table 6. Circular Business Model Canvas: Food Waste Prevention Bornholm – a network of opportunities. Source: author, adapted from Lewandowski.

<table>
<tr><th colspan="5">Food Waste Prevention Bornholm – A network of opportunities</th></tr>
<tr>
<td rowspan="2">Partners
Waste Management Entity,
Local supermarkets,
Civil Society Organisations,
Educational Institutions,
Local Communities (citizens),
associations, local governments... Creation of new partnerships.</td>
<td>Activities
Food waste prevention collaborative workshops.
Food waste prevention education activities.</td>
<td rowspan="2">Value Proposition
Good food,
Reduced price,
Environmental benefits,
Socialising with the community,
Education for sustainability…</td>
<td>Customer Relations
Events with open participation for customers,
Invitation to share social media posts on food waste prevention with the community…</td>
<td rowspan="3">Customer segments
Individuals, families, groups, tourists, residents…</td>
</tr>
<tr>
<td>Key Resources
Food soon to reach best before date.
Food discarded for sale because of packaging defects.</td>
<td>Channels
Social media,
Dissemination media at stores,
Word of mouth</td>
</tr>
<tr>
<td colspan="3"></td>
<td>Take-Back System
Ensuring that any food that is finally discarded, is properly treated for energy recovery.</td>
</tr>
<tr>
<td colspan="5">Adoption Factors
Organisational roles: specific tasks for employees of different entities to work on Food Waste Prevention Bornholm,
Internal training/information sessions,</td>
</tr>
</table>

Now, the circular business model canvas and other literature can serve as a tool for entities that want to integrate circular economy principles in their activities. However, as an answer to the lack of empirical evidence on its validity (Lewandowski, 2016) and with the goal of providing specific examples of how the framework can be applied to retail food waste prevention on Bornholm, an example action will be described hereunder.

The activity is a monthly cooperative event, itinerant around the island, to promote food waste prevention habits in the local community:

Table 7. Food Waste Proposition proposal. Source: author.

Activity	Food Waste Prevention Recipe Workshop
Partners	BOFA, retailers, Stop Madspild Lokalt, Citizens
Key Resources	Food from retailers, that is reaching the best before date on that day
Value Proposition	Good food, education/training on food waste prevention techniques, environmental benefits
Customer relations	Direct participation of customers in the event, follow up social media post with pictures of it and pictures from the final dishes
Channels	Facebook posts from BOFA, Stop Madspild Lokalt, retailers informing of the event (including details such as time, place and guestlist sign in). Posters/board notice announcing the time and place of the event, placed in the participant stores of the area.
Customer segments	Mainly residents in that area, members of the local community, though open for participation.
Frequency	Depending on attendance, ideally monthly
What and How	A daily event, that gathers BOFA (as educator), retailer (supplying with the food), Stop Madspild Lokalt (organiser, transporting food), and civil society as attendants. The idea is to gather donated food by supermarkets, which is close to the best before date, bring it to a public area and sort it by type of food. Having the food organised by types, a specialist from BOFA (one of the workers, Mathias Kjærgaard, is a certified chef), proposes a series of dishes to prepare, or batch cooking/preservation techniques that will make the products last longer and perform the cooking in an open kitchen set up. Ideally, attendees can try the result on site. The idea is to have a collaborative, enjoyable and participative event with the community. Spreading the word on food waste prevention techniques on Bornholm. For the retailers, donating part of this food can be economically (saving costs on waste transport) and socially beneficial (reinforcing the brand as an environmentally committed one). Further, Stop Madspild Lokalt can use the event to try and promote their activities around the island and hopefully expand their volunteer network.
Where	Public or community buildings or areas, local squares, *forsamlingshuse*, etc.

This example serves as a conclusion to the analysis, leading to the discussion.

MAIN TAKEAWAYS – ANALYSIS: BUSINESS MODEL CANVAS

- The Business Model Canvas applied to circular economy principles is still a conceptual framework that nonetheless shows a number of characteristics to follow by entities that want to adapt their activities to circular economy.
- Creation of partnerships is seen as one of the key factors in transition to circular economy.
- In Bornholm, actors with the common interest of food waste prevention should therefor group together and try to implement solutions that can help them achieve their common goals.

Discussion

Retail food waste is a problem affected and influenced by different actors of the supply chain, each of them with different roles in it.

Retail food waste can be interpreted as a complex problem, which defines complexity as acknowledging the problem, but all the available information about it is not well understood, and it counts with a complex network of interconnected systems. In order to solve this type of problems, it is impossible to implement a detailed planning and it is critical to have iterative and incremental holistic developments. Open discussions, with people generating innovative ideas to help entities develop strategies are encouraged (Fierro, Putino and Tirone, 2018).

As further research on circular business models should be directed to verify its applicability, Bornholm, with its 40,000 people society living on an island, presents an ideal scenario for this. The Municipality, with the 2032 zero waste vision in mind, has the ability of leading the way for others by promoting good work relationships with civil society through projects that challenge the norm (Christensen, Hjul-Nielsen, Moalem and Johansen, 2020).

So, it is reasonable to think that exploring new collaborations between different actors to prevent food waste places Bornholm on the right track, and it is further aligned with the European Circular Economy Action Plan, that aims, among other, to enhance services and business models that transform consumption patterns so that no waste is generated (European Union, 2020).

A possibility to extend prevention initiatives on the island through enhancing the CSO network and other actors by collaborative events, such as the Food Waste Prevention Bornholm, seem not only plausible but convenient. As mentioned, CSO's and retailer partners are far from reaching a number to increase the prevention on Bornholm. However, for the transition to circular economy, local governments have a critical role (Lewandowski, 2016).

Furthermore, similar initiatives to the suggested one are taking place around other parts of Europe, such as the Refood initiative in Porto, which diverts edible food waste from landfilling by distributing it. In this city, donations to food banks account for 13% of edible food waste, yet there is potential to rise this number up to 50% (Ellen MacArthur Foundation, 2019).

Using Bornholm as a testbed for a food waste prevention network seems thus plausible. The current status of food waste prevention is working well enough through the partnerships between CSOs and retailers (Niclas, 2021), however, a 6 out of 27 participating supermarkets and a CSO working with 14 volunteers appear as limited if the prevention wants to be extended to other parts of the island.

In terms of low participation numbers from supermarkets or volunteers, such an event (or series of them), can result in a pull effect that draws more individuals and retailers (specially, those not currently collaborating with Stop Madspild Lokalt) to consider their collaboration. Pull effect is usually drawn by social media networking, word of mouth, media coverage and advertising, among other, channels which are indicated in the research (Pull Marketing Strategy - Overview, Illustration and Practical Example, n.d.).

At the same time, the network and its events can also be used as an educational platform that provides feasible solutions for in house prevention measures as well as at the supermarket level, achieving a multiplier effect. Furthermore, this is aligned with the European Commission's

standpoint on food waste knowledge: “More information on the issue is necessary to determine the scale of the problem and to identify appropriate measures that could be taken” (EC, 2010).

Nonetheless, the results of the research proved in line with the sustainability vision approved in 2018 by the Municipal Council of Bornholm, and its possible implementation is up to the different actors’ evaluation and feasibility. The next step would be to really test such an initiative, as circularity in business models of public sector organisation or NGOs is still seen as an unexplored area (Lewandowski, 2016).

So, it is safe to conclude that Bornholm not only has the potential to test food waste prevention initiatives in the Municipality, but can also set an example in line with their vision, of how local partnerships can prove useful in transitioning to a more sustainable society.

Conclusion

Applying circular economy principles to the food supply chain has economic, societal and environmental benefits. Economically, opportunities appear in the line of edible food redistribution, ensuring this surplus (with market value) is used rather than discarded. Furthermore, this can also address food security issues and environmental ones, in terms of greenhouse gas emissions and soil degradation (Ellen MacArthur Foundation, 2019).

With this background, and as it has been documented throughout the research, new forms of collaborations are critical to achieve specific sustainability goals as well as global ones set by the SDGs. The research results follow Circular Economy principles and is intended to provide real solutions, that can be tried out, to a lesser of further extent, on Bornholm.

Furthermore, the research maps out and analyses what initiatives have been carried out so far and sets up a plausible path for ideas that can be done in the future. For BOFA, not only as waste management entity but as local authority, too, this means it can lead by example in terms of food waste prevention activities.

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