FleXskrald: The role and impact of incorporating a social economy enterprise and electrification of centralized waste collection on the commercial recycling system in Aalborg

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Figure 1. *Tripl*, Danish-designed electric moped and electric van for waste collection for FleXskrald. The three flex-jobbers and project leader from Huset Venture North Jutland (FleXskrald, 2019b)

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Summary

FleXskrald is a three-year project co-funded by EU to utilize smaller electric waste collection vehicles to collect recyclable waste generated from the shop and businesses on the main pedestrian streets of Aalborg's city center. The project was first conceived of by Aalborg Municipality to address the continuing environmental impact of incinerating commercial recyclable waste from shops and businesses. This initiative is also in line with the Danish government's waste management plan to curb Denmark's reliance on incineration and to strengthen the transition to a circular economy. FleXskrald is a partnership between various stakeholders from both public and private sector, mainly between Aalborg Municipality as the project facilitator, a social economy enterprise called Huset Venture North Jutland (HVN), an online waste management app Rezycl.com, and data collection from Aalborg University. HVN provides labor for the waste collectors required for the FleXskrald project who are considered "flex-jobbers." They are people who can only work reduced hours due to various reasons beyond their control (i.e. disability, illness, etc.) and are usually outside the traditional job market. Therefore, FleXskrald project provides opportunities for these flexjobbers by offering them "small but meaningful jobs." The FleXskrald model collects and sorts recyclable waste such as cardboard, paper and plastic from its customer base which ultimately gets delivered to a local recycling center. The potential target customers for FlexSkrald are small-medium businesses that are currently without any agreement with the private waste collection services and who dispose of their business waste by driving it to the local recycling station using fossil fuels, or by utilizing the shared residential municipal bins collected (not legal practice) by the diesel refuse collection trucks from Aalborg Municipality.

This research sets out to investigate the potential associated environmental and social impact of FleXskrald's business model that addresses the five relevant Sustainable Development Goals (SDG) that challenge issues with regards to of inequality, climate action, environmental degradation, job creation and sustainable communities as part of its project aim. Furthermore, to understand the motivations behind the incorporation of social and environmental causes into the waste sector's core business operations, the Danish context for Corporate Social Responsibility (CSR) is reviewed to identify avenues to further strengthen CSR for the public and private sector in the waste management industry. The results from the research aim to respond to FleXskrald's goal to influence the private waste management industry that is currently responsible for the commercial sector to adopt FleXskrald's model (i.e. electrification of RCVs etc.) and the continuation of the project to extend to other smaller cities in Northern Jutland.

To answer the proposed research questions, a mixed-method approach was taken. First, to investigate the business-as-usual (BAU) waste disposal behavior of the shops and businesses a quantitative approach was preferred to gather data through surveys since the trend of recycling could be measured through empirical data collection. A qualitative approach was deployed through semi-structured interviews with the shop owners, main stakeholders and various industry experts to understand their experiences, knowledge and opinions on the current commercial waste disposal system and meaning-making practices of human subjects such as the issue of 'meaningful job' creation. Furthermore, to effectively address the research objective, various sources published in peer-reviewed academic journals or reputable publishing houses enabled a dependable and effective literature review that lead to valuable data and insights appropriate for the Danish context. The findings of this research indicated the associated potential environmental impact to be:

- 1. 58% CO₂ reduction potential from utilizing electric vehicles (EVs) for waste collection from the potential customer target group which would be replacing petrol-based passenger cars.
- 2. 6% CO₂ reduction potential from diverting paper/cardboard waste from incineration and 55% CO₂ reduction potential from diverting plastic waste from incineration.
- 3. 10dB of the potential reduction in noise level from replacing current diesel RCVs with EVs, thus potential reduction of 33% in "annoyance" levels of residents living on the pedestrian streets.
- 4. A case for a reduction in air pollution in Aalborg's inner cities from diesel trucks that contains carcinogenic substances that are detrimental to human health.

The findings of this research recommend the following opportunities to increase FleXskrald's environmental impact:

- To include other recyclable waste fractions such as organic waste which has the potential of reducing CO₂ by 21-54% from recycling as opposed to the current practice of incineration. Additionally, to focus more efforts on increasing the current low level of plastic recycling.
- 2. To utilize the FleXskrald EVs in other ways, such as for delivery of goods to take back packaging waste material back to the manufacturer.

The findings of this research indicated the associated potential social impact to be:

- 1. The flex-jobbers working for the FleXskrald project reported high levels of job satisfaction, in particular, due to being able to contribute towards the environment and having a job. In the Danish context, this has a huge impact on the overall well-being and self-identity of flexjobbers to have a job due to the increasing social and political pressure.
- 2. There is a potential for flex-jobbers to progress from a position of dependence on HVN's support to a higher level of independence through the work experiences gained through FleXskrald, especially with regards to attaining future job opportunities.

The findings of this research recommend the following opportunities to increase FleXskrald's social impact:

- 1. Importance of extending FleXskrald's services outside waste collection to continue to get involved with the local community to raise awareness of the project and increase its impact, but to also provide more opportunities for flex-jobbers to contribute towards a 'greater good.'
- 2. The waste industry is well suited for flex-jobs, presenting an ideal opportunity for proactive incorporation of flex-jobbers to create more jobs in the industry through CSR.

Ultimately, FleXskrald is a response to the global trend of zero emission, sustainable and livable cities that considers environmental as well as social factors. During and after the trial period of three years, further investigations on collecting 'smart' data on local air and noise pollution and an interdisciplinary investigation into the true psychological and sociological impact of flex-jobs will be paramount to harbor a deeper understanding of the potential impacts of FleXskrald. Finally, this will present a stronger case for its adoption in the private industry and other cities.

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Definitions used in this report

- Flex-job: A flexible job where the worker only works several hours as a shift rather than a full working day or works a full working day albeit with support or done at a slower pace. A flex-job is different from a part-time job because it is in reference to those who cannot work a full-time job for various reasons such as a physical or intellectual disability or other proven conditions.
- Flex-jobber: People who cannot work a normal full-time job due to a disability or other conditions that inhibit them from working. Not all flex-jobbers are the same as they have varying degrees of difficulty and dependence. Flex-jobbers have usually been outside the traditional job market for a period of time.
- **Recycling station:** In Danish *Genbrugsplads.* A waste disposal station run by the local municipality where one can go as an individual or as a business (businesses need to register and pay) to dispose of various types of waste either for recycling or for incineration.
- **Recycling center**: This is where companies like *Stena* or *Ragn Sells* sort and pretreat recyclable materials either to be recycled in their own plants or ready to be transported (sold) to another recycling plant where the recyclable material is reformed into new material.
- **Municipal waste:** In Danish *restaffald* or *affald*. A mixed waste that is not recyclable (such as household waste) and is usually headed for incineration in Denmark (also referred to as *småt brændbart* in Danish).
- **Refuse and/or waste:** There are many terms that describe waste in the English language such as garbage, rubbish, trash, refuse, waste etc. Some are American English terminology, and some are British English. In general, as verbs, the difference between refuse and waste is that refuse is to decline (a request or demand) while waste is to devastate or destroy. These two terms are used most frequently in the various literature references in this report hence for the purpose of clarity and consistency, this report will use these two terms only.

List of Abbreviations and Acronyms

AAU	Aalborg University
AAK	Aalborg Kommune (Aalborg Municipality)
BAU	Business-as-usual
BEV	Battery Electric Vehicle
BAU	Business-as-usual
CGO	Center for Green Transition (Center for Grøn Omstilling)
CO	Carbon Monoxide
$\rm CO_{2(e)}$	Carbon dioxide (equivalent)
CSR	Corporate Social Responsibility
dB	Decibels
\mathbf{EC}	European Commission
EU	European Union
GHG	Greenhouse Gas
HVN	House Venture, North Jutland (Huset Venture, Nordjylland)
ICEV	Internal Combustion Engine Vehicle
LEZ	Low Emission Zone
MPG	Marius Pedersen Group
NBE	Netværk for Bæredygtig Erhvervsudvikling NordDanmark (Network for
	Sustainable Business Development in Northern Denmark)
n.d.	No date
NOx	Nitrogen Oxides
\mathbf{PM}	Particular Matter
RCV	Refuse Collection Vehicle
RE	Renewable Energy
SDG	Sustainable Development Goals
SO_2	Sulphur Dioxide
SME	Small Medium Enterprise
UN	United Nations

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1. Introduction

This research paper aims to investigate the potential environmental and social impact of the threeyear pilot project called *'FleXskrald'* (English translation: *'flex-garbage'*) co-financed by the EU's Structural Funds through the Smart Urban Innovation Call that officially launched on the 26th of March 2019 in Aalborg Denmark. FleXskrald is a new model of commercial waste collection for recycling paper, cardboard and plastic waste produced¹ by the shops/businesses on the pedestrian streets of the inner city of Aalborg. It aims to close the loop in the waste management system by embracing circular economic principles primarily focused on 'recycling' out of the 10Rs of the waste hierarchy (refer to Figure 2) (Potting, Hekkert, Worrell, & Hanemaaijer, 2017).

The expected environmental impacts of this project are CO₂, air and noise pollution reduction from the use of an electric moped² and an electric van (refer to Figure 1) that will replace the current traditional diesel refuse collection trucks in the pedestrian streets or the petrol based private passenger vehicles driven by the shop owners as a means of waste disposal. Furthermore, an important aspect of the project is to ensure that the waste produced in the service sector³ ends up in the recycling centers rather than being incinerated (FleXskrald, 2019a). Additionally, there is an associated social impact, which is the creation of 'small jobs with meaning' (ErhvervsNetværk 9220, 2018) in Northern Jutland. The FleXskrald project currently provides four positions that are considered flexible jobs ('flex-jobs') to a relatively large group of people in Denmark⁴ who have reduced working capacity and has normally been outside the traditional job market due to various reasons, mainly that of permanent disability (Sif Boddum & Sletting Fischer, 2019). This research aims to assess this type of social inclusion and partnerships with various local stakeholders to understand the impact on the individuals ('flex-jobbers') and the local community.

FleXskrald has four project partners (co-financed): Aalborg Municipality is responsible for the conception and project management, Huset Venture North Jutland (HVN) is providing flexible workers *'flex-jobbers'*, Rezycl.com is providing a smart waste management web app that analyzes data and Aalborg University is responsible for the data collection on factors such as localized air pollution. Through this partnership, the FleXskrald project aims to integrate social objectives with an environmentally friendly commercial waste management in the inner city of Aalborg.

¹ Other types of recyclable waste are planned to be included to this project such as polystyrene packaging (Quintero Hansen & Schultz Andersen, 2019).

 $^{^2}$ Bicycles were not considered due to the heavy labor it would require to deliver large amounts of plastic and cardboard/paper waste (Sif Boddum & Sletting Fischer, 2019).

³ The service sector consists of both public and private service, which in turn consists of different subgroups. Within the service sector, retail, transport and freight handling, communication, culture, finance and private services generate by far the largest amount of waste (Grubb, Lindholt Nissen, & Sørensen, 2018).

⁴ Approximately 450,000 Danes of working age are outside the labor market. They can be an early retiree, who can only work a few hours a week at a job due to disability, or they can be a mentally disadvantaged person but who can still work for 37 hours albeit at a reduced rate, requiring clearly defined tasks and great support (Huset Venture Nordjylland, n.d.).

2. Background

Denmark is known for having the highest municipal waste production per capita in the EU and its reliance on incineration as a key method of waste disposal (L. L. Nielsen & Skaarup Justesen, 2013) that has a long history, spanning over a century (Kleis & Dalager, 2004). Denmark found success with advancing its incineration technology since the 1970s, where it exemplified world-renowned waste-to-energy incineration technologies that provide energy and district heating with the world's cleanest pollution filter (Danish Ministry of the Environment, n.d.; Kleis & Dalager, 2004). However, this dependence on incineration for waste disposal may have caused a paradoxical barrier for a more environmentally friendlier form of waste management in Denmark. There is a strong economic and environmental incentive to keep incineration plants at its most efficient operation, i.e. at its full capacity. Therefore, Denmark has had to purchase foreign waste materials from other EU countries to keep its incineration plants at its most efficient capacity (Grubb, Lindholt Nissen, & Sørensen, 2018; Møller Andersen et al., 2016). This continual long-term operation of incineration plants which is dependent on importing waste is not in line with the ambitious national climate goal such as becoming independent from fossil fuels by 2050 (including burning waste such as plastic that uses oil to create energy) (Danish Ministry of Energy, Utilities and Climate, 2016). Consequently, there have been recent efforts from the Danish government to curb Denmark's reliance on incineration. In 2013, a new waste management plan was proposed: "Denmark without waste – Recycle More, Incinerate less" (L. L. Nielsen & Skaarup Justesen, 2013; The Danish Government, 2013). The Danish government established an Advisory Board for Circular Economy, to strengthen the transformation to a more circular economy (Miljø og fødevareministeren, 2017). This means that waste and resource consumption needs to be minimized, ensuring that the essential value of products and materials are conserved as much as possible, and when a product has reached the end of its life cycle, it needs to be given a new life and value (Charter, 2018). This value has also been addressed by the European Commission, which has responded to ensure sustainable growth in the EU by adopting a Circular Economy Action Plan in 2015. This plan shifts the waste management paradigm from the traditional, linear economy to a circular economy (see Figure 2). Key elements of the revised waste proposal include a common EU target for recycling 70% of packaging waste by 2030 (specifically, paper and cardboard by 85% and plastic by 55%) (European Commission, 2019a, 2019b). This proposal is further backed by the Zero Waste stance by the European Commission (2017), which emphasizes that "waste management is one of the main areas where further improvements are needed and within reach: increasing waste prevention, reuse and recycling are key objectives both of the action plan and of the legislative package on waste."

Much of the emphasis has been on recycling (R8) which is a step above Recover (R9) to transition away from incineration, but what the framework set by Potting et al., (2017) indicates is that the greater environmental gain from moving even further up the ladder of circularity. It needs to place equal if not more importance on "smarter product use and manufacture to extending the lifespan and use of the product and its parts" (see Figure 2). However, this transition to a circular economy is not easy and is challenged by various factors such as social and economic

barriers, regulatory and market failures (Sheppard, 2016). It requires a great deal of willingness to cooperate between the various stakeholders and actors in the circular economy to address these challenges (Sheppard, 2016).



Circularity strategies within the production chain, in order of priority

Figure 2. The 10Rs of waste hierarchy shows the transition from a linear economy towards a circular economy (Potting et al., 2017; RLI, 2015).

The past few years the EU has been enacting reforms to tackle the issue of escalating recyclable waste. One of the key reasons is because, up until the end of 2017, Europe has been relying on exporting their excess recyclable waste to China. Since 2017, China has increased its stringent restrictions on accepting recyclable waste from the EU. This has caused waste to exceed its recycling capacity in the plants throughout the EU⁵ (Tamma, 2018). In response, the European Commission

⁵ Much of the recyclable waste that has been rejected by the Chinese government is now being diverted to Malaysia, Vietnam, Thailand and Indonesia (Tamma, 2018). Some of these countries have also started to reject accepting waste from wealthier countries and shipping back tons of plastic waste back to its origin (Al Jazeera, 2019).

has devised a vision to turn plastic waste into an economic commodity with its *Plastics Strategy*, the goal of which is for all plastic packaging to be recyclable or reusable and increase recycling targets for other packaging materials by 2030. This means that the EU's current recycling efforts need to increase by fourfold, which is expected to cost 16.6 billion euros (Tamma, 2018). Furthermore, plastics have been the biggest focus in the EU as the recent ban on single-use plastics will come into effect by 2021 in all EU member states with measures for 90% of plastic bottles to be recycled by 2029 (Rankin, 2019). These EU measures have an impact in Denmark where a strong presorting initiative has not been in place, especially from households and consumers (Møller Andersen et al., 2016). Therefore, there has been a push for stronger initiatives from municipalities to sort more recyclable waste (especially plastic), but this is still in its early stages (Bro Bystrup, 2019).

Moreover, effective management of waste material is not an issue bound to Denmark or the EU, but a global issue due to increasing densification of cities that produce large amounts of waste that needs to be sorted, collected and recycled. Therefore, investigating an environmentally friendlier solution other than incineration is an important and viable issue to tackle in Denmark.

Nevertheless, it is important not to undermine the significant contribution and role the incineration industry has played in Denmark in the past to transition away from landfilling by becoming one of the countries in Europe with the lowest landfill rates (Kleis & Dalager, 2004). This was a result of several hugely influential political and economic instruments that were implemented such as in the Landfill tax in 1987 and the Landfill ban in 1997 to divert the waste from landfill towards incineration to protect the quality of groundwater, reduce GHG emissions as well as strengthen the generation of district heating and electricity (Danish Ministry of the Environment, n.d.). Incineration is still a necessary measure in a global market where recycling is difficult with low demand. Therefore, the change of paradigm from incineration to one of recycling will not happen overnight for Denmark. However, the benefits of curbing incineration to increase recycling are now recognized. Furthermore, it is crucial that Denmark continues to climb the ladder of waste hierarchy to transition to a more circular economy.

2.1 Recycling statistics for the service sector in Denmark

Since the waste management plan to curb reliance on incineration was proposed in 2013, improvements have been made in certain industries such as the service sector in increasing its overall recycling whilst decreasing incineration⁶. Data from the Danish Ministry of Environment and Food between 2014 to 2016⁷, indicate that the national recycling rate stabilized at 68-69% and the top

⁶ "The service sector's total waste production was just over 1.6 million tonnes in 2016 with only the retail sector contributing 278,000 tonnes (17%) in 2016 decreasing from 349,000 tonnes (22%) in 2014. The big drop in the retail sector is primarily due to the fact that waste suitable for incineration has fallen in the industry (Grubb et al., 2018). The most common types of waste generated by the service sector is, waste that is suitable for incineration, which amounted to 528,000 tonnes (33%) in 2016, one third of the total amount of waste generated from the service industry. This amount has fallen by 5% since 2014" (Grubb et al., 2018).

⁷ 2017-2018 figures yet to be published and recycling rate is expected to increase (Bro Bystrup, 2019).

four sectors (i.e. household, service, industry and construction) that contributed the most waste have actually increased its waste footprint over that period (Grubb et al., 2018). The overall average recycling rate of the service sector reports at 59% as of 2016 which has increased from 51% in 2014, whilst incineration has decreased from 46% to 38% during the period of 2014 to 2016. Landfilling remained unchanged at 2-3% (Danmark uden affald, 2013; Grubb et al., 2018). Additionally, statistics show that a larger amount of organic, plastic and cardboard packaging waste was recorded to be generated in 2016, which is due to an increased national focus on sorting out these waste fractions from the service sector in order to increase recycling (Grubb et al., 2018). Since 2016 there have been more efforts from the local municipalities to increase the recycling rate in Denmark, therefore the figures for 2016-2018 is expected to show an increase in recycling rate (data not yet published) (Bro Bystrup, 2019).

2.2 Aalborg's current commercial recyclable waste collection for the service sector

Currently, in Denmark, the local municipalities are responsible for collecting all household waste for incineration and recycling. However, commercial waste is collected and treated on general market conditions, allowing the private waste management companies⁸ and inter-municipal companies⁹ to secure the market (Bro Bystrup, 2019; Dakofa, n.d.). This is due to a legislation change in the 2007-2010 that led to the privatization of commercial waste management (Bro Bystrup, 2019; Holm, 2016). However, Aalborg Municipality is the only city in Denmark that has the jurisdiction to collect municipal waste (for incineration) from the commercial sector. The commercial recyclable waste is mainly collected by the private waste management companies who have their own internal system for waste collection, handling, sorting, tracking recycling and/or exporting its own waste fractions overseas to other recycling plants. Consequently, the data on commercial recyclable waste generated in Aalborg is being held by these private companies due to the changeover (Bro Bystrup, 2019; Hyldgaard, 2019).

Another option for commercial businesses/shops to dispose of their operational commercial waste is to utilize the recycling stations (in Danish: *Genbrugsplads*) operated by Aalborg Municipality. These stations do not offer collection services like the private companies, they can be used through self-disposal only. These recycling stations are used by both businesses and residents to voluntarily dispose of large amounts of recyclable waste or specialized kind of waste that need to be disposed of separately. For the business owners, the regulations require businesses to register first and pay for waste disposal at the local recycling station which is calculated based per visit and dependent on the size of the car (Bro Bystrup, 2019). There is a 'grey area' of commercial waste recycling, where some of the shops in the inner city of Aalborg have a lease agreement with

⁸ Some of the major private waste collection companies in Aalborg are Marius Pedersen, HCS/Solukær Pedersen Brønderslev, Nordjysk Forretnings etc.

⁹ Local authorities are mainly organized in inter-municipal companies that own incineration plants, landfills etc. (i.e. Reno Nord is an incineration and recycling plant owned by four local municipalities which serve the greater Aalborg region) (Bro Bystrup, 2019; Dakofa, n.d.).

landlords who share the Aalborg Municipality bins¹⁰ provided for the residents living above the shops (Bro Bystrup, 2019). This practice of businesses using residential bins is illegal, indicating the lack of coherent commercial recycling system that can measure, track and collect data in a transparent way to ensure that the waste produced by the service sector is indeed recycled.

2.3 FleXskrald model: Electrification and socio-economy model of commercial recycling collection

FleXskrald was a conception from the Network for Green Detail¹¹ from Aalborg Municipality which consists of a network for retail stores in the city of Aalborg who wants to start or further develop their work with sustainability. Thus, the Network for Green Detail works actively to strengthen the environmental profile of these retail stores and provide opportunities to share knowledge among each other and inspire sustainable solutions, across industries (Center for Grøn Omstilling, n.d.). The idea of FleXskrald came about whilst realizing the need to address the problem of commercial recyclable waste to be collected in a more environmentally friendly manner whilst utilizing the available central waste collection space provided by the main shopping mall and supermarket in the city center of Aalborg (i.e. provided by Salling and Føtex).

EU granted funding for 2.3million Danish kroner $(DKK)^{12}$ out of the estimated 4.6million DKK budget, in hope to utilize this pilot project to assess if there was scope to institutionalize this model of electrification of refuse collection vehicles on the pedestrian streets through the centralized collection point after its trial period. Its goal is to decrease the environmental impact on the commercial waste sector and to investigate whether the private waste management companies might adopt the FleXskrald model and to see if it could be implemented in other smaller cities around Aalborg (i.e. Vodskov) (Quintero Hansen & Schultz Andersen, 2019). The project also addresses various Sustainable Development Goals (SDG).

The reasoning behind the strategy to electrify the refuse collection vehicles is due to the fact that the electricity output in Denmark has reasonably high renewable energy profile. The latest data from 2017 showed that 63% of the electricity output is of renewable energy (RE) source¹³, which is an increase from 61% in 2016. The RE share of electricity generation in Denmark is expected to continue to increase, almost doubling the current level of RE-based electricity generation in the course of the next ten years (Energinet, 2018).

¹⁰ Some of the residents living above the shops, do not have space nor access to recycling bins for plastic/metal or paper/cardboard. These recycling bins are also picked up once every two weeks which gets full quickly.

¹¹ Martin Quintero Hansen is the project leader from Network of Green Detail (Netværk for Grøn Detail) from Center for Green Transition (CGO) at the Aalborg Municipality and the main founder of FleXskrald (Quintero Hansen & Schultz Andersen, 2019).

 $^{^{12}}$ It is co-funded by all the stakeholders, either through monetary means or through labor (hours) (Quintero Hansen & Schultz Andersen, 2019).

 $^{^{13}}$ The renewable energy sources in Denmark comprise predominantly of wind power, biomass, photovoltaics, biogas and hydroelectric power (Energinet, 2018).



Figure 3. Main pedestrian streets of Aalborg's inner city center (indicated in red) stretching over approximately 1.5km with the central collection area at the back of Salling mall and Føtex supermarket.

As shown in Figure 4, FleXskrald is a four-step process of recyclable waste collection in the pedestrian shopping streets of the inner city of Aalborg (see the map of Aalborg in Figure 3). One of the main restrictions on the FleXskrald project is its potential target customers. FleXskrald is not allowed to interfere with the current private market companies' existing customer base, therefore, it can only target shops and businesses who do not have a collection scheme arranged with a private waste management company. They are shop/business owners that drive to the local recycling station to dispose of their waste or those who use the Aalborg Municipality household bins provided for the residents living above (Brauer, 2019; CSR.dk, 2019).





Figure 4. Diagram of the FleXskrald recyclable waste collection process

The FleXskrald service is based on a subscription scheme that gives them a flexible waste collection period that matches the market prices of existing private waste management companies (see Appendix B.1, Table 11). The idea is to make recycling easy and convenient for the shop/business owners in order to increase the recycling rate.

In close partnership and collaboration with Aalborg University, there are plans for the electric moped to become a mobile testing station by installing air or/and noise pollution sensors to investigate if the electrification of refuse collection vehicles would make a significant impact on the quality of urban life for the residents. This data could be utilized to influence the private commercial waste management market to adopt early electrification of refuse collection trucks which can reduce noise, pollution and CO_2 (Quintero Hansen & Schultz Andersen, 2019).

Another key partnership for FleXskrald is with Huset Venture North Jutland (HVN). HVN is a social economy enterprise that functions on a set of key values that differs from a typical corporate business. These values are i) prioritizing the individual and the social objective over the capital that requires reinvestment of most of the profits to carry out sustainable development objectives and ii) services of interest to members or of the general interest of the business (Huset Venture Nordjylland, n.d.). HVN provides recruitment, support and training services for '*flexjobbers*' who are vulnerable people outside the job market. This is a unique labor market arrangement to Denmark (Brejning, 2016). Nevertheless, HVN as a middleman for the employer and the flex-jobbers have various barriers to overcome, such as discrimination for their disabilities or previous lifestyle choices and meeting the challenge of accomplishing social objectives and financial profit (Sif Boddum & Sletting Fischer, 2019).

It is important to note that despite FleXskrald's aim to encourage more recycling of recoverable materials, one of the most important steps in the process is waste minimization (i.e. R0 Refuse, R1 Reduce, R2 Reuse etc.) which is in hands of the product designers, manufacturers, consumers, local governments, organizations and businesses/shop owners. However, for the business community in Denmark, there is a pressing opportunity to create changes in the current Business-As-Usual mode of recyclable waste disposal to a circular economy that can have a positive impact on the urban environment as well as the local community and the economy (Sheppard, 2016).

2.4 Increasing densification and urbanization

The percentage of people living in urban areas will increase from 55% to 68% by 2050 worldwide (UN, 2018). This trend is also reflected in Aalborg which faces rising population, i.e. approximately 2,000 new inhabitants per year (AAK, 2016). Increasing urban densification is gradually putting demands on existing services and infrastructure. Cities are responding by rapid expansion and development of new strategies to meet the increasing demand. However, it has become increasingly important to meet the challenges of ensuring sustainable urban development, which implies the creation of both resource efficient systems and effective urban policies to achieve attractive cities with good quality of life (Sepe & Pitt, 2013). Therefore, many major cities around the world have adopted the move towards increasing pedestrian centric cities, banning internal combustion engine vehicles to reduce air and noise pollution along with reducing its reliance on fossil fuels to improve the city's livability whilst reducing its environmental impact (Clarence-Smith, 2018). What this urban trend translates into for the waste management sector is the increasing pressure from government and demand from citizens to move towards zero-emission and sustainable city equipped to deal with various challenges of today.

2.5 Existing research

The current state-of-the-art research has largely focused on the environmental and economic impacts of waste management, mostly quantitative and correlational studies to benefit the existing market. For example, they are research conducted by, Dong, Geng, Yu, & Li (2018), Mendes Campolina, São Leandro Sigrist, Faulstich de Paiva, Oliveira Nunes, & da Silva Moris (2017) and Liu et al. (2018). However, this research sets out to contribute with more qualitative explorations of the social returns and to assess the importance of considering broader implications such as social inclusion of vulnerable people in North Jutland through flex-jobs, strengthening the local partnerships between the public and private sector and increasing the quality of livability in cities like Aalborg. This research will also help identify further avenues of investigation and ways to climb the ladder of waste hierarchy from incineration to recycling and beyond. Identifying further directions on future research will help inform the FleXskrald's project to a significant increase in its impact and target its efforts accordingly during its pilot period.

3. Research methodology

3.1 Problem Statement

The overarching research question is,

"What is the potential role and impact of the FleXskrald model that incorporates a social economy enterprise and the electrification of centralized waste collection on the commercial recycling system in Aalborg?"

The intention of this research is to understand if there are any potential social and environmental impact due to the intervention of the FleXskrald model on the current waste recycling practices in the inner-city businesses of Aalborg. The outcome of the potential impacts could inform whether the FleXskrald model is appropriate for adoption in the private waste management industry and its potential for continuation after the three-year trial period in the smaller cities of Northern Jutland. The research initially sets out to assess the potential impacts through the utilization of existing frameworks provided by the Sustainable Development Goals Capture Tool designed by the Danish consulting firm NIRAS. Furthermore, the mandatory CSR reporting for the private companies in Denmark is reviewed to understand the context that influences CSR reports and what aspects of CSR the private industry focus on that could be appropriate for the FleXskrald project to influence. The investigation of the potential social and environmental impacts forms the sub research questions to this research (see Overall research process in Figure 5). The main variables that will be used to further assess the direct environmental impacts will be CO₂ emissions reductions from recycling compared to incinerating and replacing Internal Combustion Engine Vehicle's (ICEV) diesel and petrol use with Battery Electric Vehicle (BEV). Furthermore, potential air pollution and noise pollution from the current use of ICEV is assessed. For the social impacts, meaningful job creation from the viewpoint of the flex-jobbers will be discussed along with the social impact from strong local partnerships such as Huset Venture North Jutland. The research aims to identify any further avenues for the FleXskrald project to increase its potential environmental and social impact.

3.1.1 Overall research process

The overall research process is illustrated in Figure 5 below, with the appropriate methodological approaches encompassing every step and finally arriving at the conclusion and discussion of the implications on the findings on the continuation of the FleXskrald model and potential future investigation required for better understanding of this project.



Figure 5. Overall research process

3.2 Overall methodological approach

3.2.1 Mixed-method approach

To find answers to the proposed research questions, a mixed-method approach was taken. First and foremost, it was important to investigate the business-as-usual (BAU) waste disposal behavior of the shops and businesses on the pedestrian streets of Aalborg in order to evaluate the environmental impact of incinerating rather than recycling. A quantitative approach was preferred to gather data through surveys because the behavioral trend of recycling waste could be measured through empirical data collection and thus assess the current BAU situation that could be improved. Statistical analysis was conducted afterwards. However, as a follow-up, a qualitative approach was deployed through semi-structured interviews with the shop owners. It was conducted to understand their personal experiences and opinions on the current commercial waste disposal system, to capture the concerns and factors that the researcher may have overlooked from the quantitative approach. Semi-structured interviews were the major qualitative approach in this research, such as looking into evaluating the stakeholders' (in particular Huset Venture North Jutland and the flex-jobbers) meaning-making practices of human subjects such as the issue of 'meaningful job' creation. Qualitative interviews allowed the researcher to look into the whys, how or by what means people do what they do into a generalized research outcome (Allan, Dexter, Kinsey, & Parker, 2016; Brinkmann & Kvale, 2014). This interpretive method of data collection helped recognize the connection of meaningful job creation as FleXskrald's main social impact. However, it is important to note the shortcomings of the interpretative data, which entails cautious inspection of variables because it focuses more on subjective experience and knowledge. Therefore, the results are not representative of all the other flex-jobbers' experiences and their insight should only be understood in reference to the FleXskrald project (see 3.6 Limitations and scope for more info). The various mixed-method approach for each research question is listed in Table 1.

Sub-question (SQ)	Methodology (Data collection and analysis)
SQ1: What framework/ goals can help institutionalize FleXskrald model for the private & public sector?	 Literature review (i.e. white, grey, academic) Qualitative data analysis of the semi-structured interviews of the representatives of the main private waste management company and insights from other experts Qualitative analysis of the SDG framework tool designed by NIRAS Qualitative analysis of the Marius Pedersen Group's CSR report in combination with data gathered from a semi-structured interview of the spokesperson from MPG.
SQ 2: What is the potential environmental impact of FleXskrald project?	 Literature review (i.e. white, grey, academic) Empirical data analysis from other studies that are relevant for FleXskrald (i.e. CO₂ Coefficients for air pollution, different types of fuels, recycling vs. incineration, sound levels dB for noise from different vehicle types etc.) Empirical data collection via surveying BAU behavior of shop/owners in the main pedestrian streets of Aalborg and statistical analysis of data gathered (N=64). Quantitative data analysis of the potential CO₂ and kWh reduction due to FleXskrald activities from the N=37 surveyed shops that provided waste fraction quantity data Qualitative data analysis of the semi-structured interviews of the representatives of the main private waste management companies and insights from other experts in the industry (i.e. MPG, HCS) Qualitative analysis of relevant case studies (national and international examples)
SQ 3: What is the potential social impact of FleXskrald project?	 Literature review (i.e. white, grey, academic) Qualitative data analysis (interpretative methods and survey utilizing Likert scale) of the semi-structured interviews of the representatives of flex-jobbers from Huset Venture North Jutland. Qualitative data analysis of the additional semi-structured interviews from the representatives of HVN & Aalborg Forsyning.

Table 1. Summary of methods used to provide answers to the research sub-questions

3.3 Literature review

After defining the research problem, the focus was on the research's overarching objective. The use of sources published in known reputable academic journals or publishing houses enabled a dependable and effective literature review that lead to providing valuable data and insights (Machi & McEvoy, 2016). Therefore, literature searches were based on some of the major databases and search engines for rigorously reviewed journal articles, including Aalborg University Library, LexisNexis Academic, Sage Research Methods, Wiley online library and Google Scholar. The scope of literature sources included Google as a necessary measure due to some relevant publications not included in scientific databases, such as the grey and white literature. Typical grey and/or white literature studies include publication from different ministries of the Danish government that provide statistics on waste recycling in Denmark. Many reports were written in Danish which was translated using Google Translate and subsequent clarification from a native Danish speaker. Some e-news articles were also utilized, as they provided the most up-to-date information on the waste industry. Official news outlets were favored such as The Guardian. Subsequently, a literature search and selection on the aforementioned databases was conducted using a structured search string based on keyword search. For example, the following search strings were used: [commercial recycling OR service sector recycling] AND [plastic OR paper OR cardboard] AND [incineration OR recycling] AND [Europe OR Nordic OR Denmark OR Aalborg] AND [environmental impacts OR social impacts] AND [air pollution OR noise pollution] AND [internal combustion engine vehicles OR battery electric vehicle] AND [meaningful job OR decent job] AND [electric refuse collection vehicle OR electric reduce collection truck] etc. Afterwards, critical evaluation and assessment of the selected literature were initiated. Since the recycling industry is changing rapidly, the paper aimed to only draw on the most recent literature where possible, to ensure the state-of-the-art of national and international recycling research was sufficiently covered. Despite the fact that no restriction was set on the publication date, the majority of the references were from 2013 onwards.

3.4 Data collection

3.4.1 Semi-structured interviews of the main stakeholders of FleXskrald and associated public and private sector stakeholders

Another source of key information was gathered through semi-structured interviews to understand the complex workings of the private and public sector's involvement in the commercial waste industry. Semi-Structured interviews are a suitable method to gather qualitative data on a specific topic. Moreover, this method was chosen as it leaves room for the spontaneous alteration of the interview topic, i.e. clarification or further explanation of issues, if necessary. To ensure all relevant topics of interest were addressed during the interview, questions were prepared in advance. The questions at the beginning of the interview were deliberately formulated to ensure that they were easy to answer and not controversial. In the main part of the interview, the interaction was structured in order to facilitate the discussion of more controversial questions. To leave the interviewee with a good overall impression, less controversial questions were asked towards the end. An example of one of the interview guides can be viewed in Appendix A.1. Generally, the questions were formulated with respect to the professional background, the expertise of the interviewee and the research questions of this research. Additionally, it was made certain that questions were openended rather than closed. During the interview, the interviewers used techniques such as paraphrasing to verify the comprehension of the interviewees' utterances. The interviews took place between 15.02.2019 and 03.06.2019. Where possible, the interviews were recorded (refer to Appendix A) and notes were taken throughout. The interviews were conducted in English and those that could not be conducted in English were translated from Danish. The interviewees were chosen with respect to their connection with the FleXskrald project as key partners but also for their experience and expertise in the recycling, waste collection and the Danish labor market. Detailed information on the interviewees and their profession are shown in Table 10 in Appendix A. First round of initial semi-structured interviews with each stakeholder was conducted as part of a strategy to aid initial background understanding of the FleXskrald project, investigating into the goals of each stakeholder and access to general information to be able to progress with the research. Some of these stakeholders were interviewed again towards the end of the research to revisit their goals and incorporate further updates and insights from the data gathered from the first two months of the FleXskrald project.

3.4.2 Email interview of flex-jobbers from Huset Venture North Jutland

Due to the sensitive, subjective and philosophical nature of the questions regarding "meaningful job," the language barrier, time constraint etc. the response to the interview questions were sent to the researcher in Danish. It was difficult to seek clarification of the answers due to the time and mental constraints of the flex-jobbers. The interview questions had to be designed in a way that was simple and short as possible, therefore, the Likert scale that is widely used was applied to the interview questions to represent flex-jobber's attitudes to the topic of meaningful job in a way that standardized their response (Hampson, 2014). For example, one of the Likert scales used ranged from Strongly disagree, disagree, neither disagree nor agree, agree to strongly agree.

3.4.3 Surveys of the shop/business owners of Aalborg's main inner-city pedestrian streets

A short 1-2minute survey was devised in order to get an understanding of the current BAU waste disposal behavior of the shop/business owners of the pedestrian streets of inner-city Aalborg. Surveys are a convenient way of finding out general patterns of behavior from a small sample of a whole population group (Orcher, 2016). In this case, the sample size was based on how many shops the researcher could attain participation within the time constraint before the official launch and promotion of the FleXskrald project. This could have affected the unbiased response of the shop owners (who could have been impacted by the marketing information given by FleXskrald), hence the quality of the data. A total of six questions was asked verbally and answers written down by the surveyor/researcher (differentiating each question between cardboard/paper and plastic). In order to increase the chances of engagement, the survey was kept deliberately short and simple as the shop owners were usually hesitant to undertake surveys during business hours¹⁴. Verbal, faceto-face surveys were preferred method as opposed to DIY written method due to the difficulty in attaining answers from the shop owners experienced by the Aalborg Municipality, who undertook a basic initial BAU survey.

The survey (refer to Appendix A.8) starts off clarifying how the shop owners dispose of their plastic and paper/cardboard waste (i.e. private waste collecting service such as Marius Pedersen, or residential bins provided by the Aalborg Municipality, or drive to recycling station etc.). Then, the second part of the question asks about how often the waste gets collected (i.e. once a week, once every two weeks etc.). Finally, the last question asks about the average volume of waste created before collection. Further clarifying questions were asked to those that were willing to engage in a longer interview asking for comments on affordability, satisfaction level etc. (refer to Appendix A.8).

3.4.4 Case studies

Case studies are a sound method to investigate "how" or "why" questions, as they require an indepth description to understand the specific phenomenon and seek out to explain the circumstances of a phenomenon (Yin, 2009). Therefore, other similar examples of the FleXskrald model was sought to understand factors for the successful and unsuccessful application of electrification of refuse collection vehicles, i.e. to understand the factors that could be applicable and important for FleXskrald to be aware of in achieving its goals. This was particularly important as FleXskrald is in its early stages, therefore, investigating into other similar case studies could give valuable insights and data that it does not yet have. To get an understanding of any associated environmental or social impacts from the electrification of refuse collection vehicles (RCV), case studies that had similar conditions and contexts as possible with Denmark was sought. This meant looking for examples in the Nordic region with similar renewable electricity outputs such as Norway and also looking into national examples such as the one implemented in Copenhagen. Due to the fact that electrification of refuse vehicles is a recent trend, operations within the past few years were included in the analysis. Since the electrification model for FleXskrald is not a refuse truck but a smaller EV (moped and van), examples of smaller electric vehicle (EV) usage was also explored. Additionally, no known case of smaller EV use for refuse collection just in pedestrian streets has been realized yet in Denmark.

3.5 Data analysis

3.5.1 CSR framework analysis

Key seminal research on the background history and cultural context of Corporate Social Responsibility (CSR) in Denmark was referred to, in order to understand its current influence on the private waste management industry. Some of the key works referred are a PhD thesis by

¹⁴ The surveys were undertaken on the least busy days of Monday and Tuesday during normal business hours between 11-4pm (1hour after opening and 1hour before closing) to increase engagement. It was also communicated that the survey would be anonymous and only utilized for research purposes.

Zinenko, (2014) outlining the success of Danish CSR due to the national institutional frameworks and as a case study, investigating the relationship between CSR and the welfare state by Brejning, (2016) and investigating into the historical and theoretical approach to CSR in Europe (Mathis, 2008). Additionally, due to the mandatory CSR reporting by big companies in Denmark, one of the biggest private waste management company Marius Pedersen Group's (MPG) CSR report was analyzed to understand the commercial private market motivation, future goals and current actions that could give insights into whether FleXskrald project have any scope or opportunities to influence its own model on the private industry. The CSR report analysis was further complemented and clarified with an interview with the environmental spokesperson for MPG.

3.5.2 SDG framework analysis

The Danish consultancy firm NIRAS has developed a new tool called the 'SDG Capture' which was utilized due to its usefulness in making an initial qualitative assessment on the levels of 'effect' by integrating Sustainable Development Goals' (SDG) targets in local projects to increase sustainability. For the FleXskrald project, the main stakeholders considered five relevant SDG out of 17. Each corresponding SDG was qualitatively assessed by the researcher from a scale of six options ranging from: major negative effect, minor negative effect, no effect, minor positive effect, medium positive effect to major positive effect on its expected effect from the operation of FleXskrald. The judgement on whether FleXskrald has a certain major positive effect on major negative effect was decided based on the existing knowledge and data collected for the FleXskrald project. The maximum scale was set by the researcher by assigning the 'major positive effect' to be based on FleXskrald's best-case scenarios, where it would result in the adoption of its business model by the private waste companies and other smaller cities in North Jutland. The worst-case scenario was assigned as a 'major negative effect' to be resulting in a decrease in recycling level due to FleXskrald's operation. The SDG Capture Tool was useful to this research to apply as a complementary guiding framework to pre-assess the various impact of the FleXskrald project.

3.5.3 The calculation and analysis of the environmental impacts

The potential environmental impact analysis was conducted on four criteria: i) CO_2 savings from recycling vs. incineration, ii) CO_2 savings from battery electric vehicles (BEV) to a diesel/petrol internal combustion engine vehicles (ICEV), iii) Air pollution from utilizing EVs, and iv) Noise reduction from utilizing EVs. Figures or co-efficient used to calculate environmental impact was based on empirical research data that was generated from a Danish context (or where possible) to simulate it closest as possible to the investigation in question. Where this was not possible, examples that resembled closest to the FleXskrald case was chosen.

Another empirical data from Hillman, Damgaard, Eriksson, Jonsson, & Fluck (2015) (refer to Table 4) is generated by a study based in Denmark. This empirical data was utilized to calculate the potential CO_2 savings from recycling, which included the energy required for secondary production of recycled material, and the potential CO_2 savings from incineration included the energy required for primary production. A study from L. H. Nielsen & Jørgensen (2000) compares the vehicle energy efficiency and specific CO_2 emission between ICEV and BEV. The electricity that powers the BEV is a critical variable since it determines its overall CO_2 emission. Therefore, despite the fact that the empirical data given by L. H. Nielsen & Jørgensen (2000) is almost a decade old, the study was set in the Danish context, utilizing the Enery21, The Plan scenario¹⁵ which is taking into consideration the future projected renewable energy percentage in the Danish national grid, which could be a condition applicable to Aalborg. However, L. H. Nielsen & Jørgensen (2000) study has discrepancies in their empirical data which is calculated for trucks that are of a smaller size than the normal refuse collection vehicles typically used by the waste management sector. Therefore, the oldest figures (1997-2000) which are the most inefficient was used instead for the calculations. This was to take into consideration the bigger g CO_2/km output a bigger ICEV refuse collection truck would emit.

Table 6

3.5.4 The analysis of the social impact

Key works in the field of occupational psychology on the topic of 'meaningful jobs' is utilised from published peer-reviewed journals along with articles referring to the Danish political pressure that influence the narrative around the unemployed in Denmark. Interview questionaires (in Danish) was utilized for the flex-jobbers to fill out with the help of support from a member of HVN to answer questions designed incorporating the Likert scale, to make it simple and quick for the flexjobber to answer. Then, their answers were translated, interpreted and analyzed via qualitative methods. Refer to Appendix A.2 for more information. Semi-structured interview materials were also utilized as qualitative data from HVN, MPG and Aalborg Forsyning.

¹⁵ "According to the Danish energy plan the decline of CO_2 emission per kWh of electricity delivered will continue. Calculations based on the expected development, according to Energy21, 'The Plan scenario' for the long-term development show 80% reduction in the specific CO_2 emission per kWh (192 g CO_2/kWh) electricity is expected for 2030" (L. H. Nielsen & Jørgensen, 2000).

3.6 Limitations and scope

This research is based on the scope set by the FleXskrald project, which limits the area of interest to the five main pedestrian streets of the inner-city of Aalborg. Furthermore, the focus and scope will be limited to the following:

- 1. The shop owners that have signed up to the FleXskrald project during the duration of this research were 10 shops on a free trial period of three months at the end of May 2019 (Quintero Hansen & Schultz Andersen, 2019). The recorded data was of less than 2 months and therefore an insignificant amount to generate any substantial data or find any established patterns for analysis to be considered for this research. Furthermore, the 2 months' worth of data collected¹⁶ by FleXskrald was incomplete and not useable for environmental impact calculation. Therefore, the data collected from the survey of the shop owners were utilized instead to predict the potential environmental impact of the FleXskrald project.
- 2.Some of the shop owners that were surveyed had difficulty with speaking and understanding English, which caused further confusion on the responses to the survey questions thus degrading the accuracy of the survey. Many also had difficulty differentiating between the various sizes of bins available to quantify the waste generated. This led to further assumptions on the amount of waste generated. For example, the photographic studies of the bins (i.e. 660L and 770L bins) located at the back-of-house of some shops revealed that there were similar but slightly different sizes of bins available (see Figure 6). Therefore, assumptions were made to translate "big bins" into standard bin sizes. Additionally, the distinction between the paper and cardboard bins were not clear as some were separated, and some were combined (See Figure 6). It is assumed that many shops produce small amounts of paper waste, therefore, it may be that paper waste could either be discarded as general municipal waste rather than recycled especially if they only have cardboard (pap) bins from Marius Pedersen as shown in Figure 6. This is because the cardboard bins should only contain clean cardboard and *not* paper as indicated on their website to ensure cleaner fractions with less sorting required (Marius Pedersen, n.d.-a). The difficulty in having access to back-of-house bins for all the shops surveyed, resulted in much of the surveyed information to be assumed when it came to bin sizes.

For the Aalborg Municipality bins, paper and cardboard were able to be combined in the same bin as shown in Figure 6. Thus, it was safe to assume that the shops that used these municipal black bins would have recycled both cardboard and paper. However, for the shops that used the bins from the municipality for plastic waste meant that they were mixed in with metal, which meant that the volume of plastic that needed to be calculated separately would be hard to determine.

¹⁶ This was due to a limitation in the Rezycl app system that could not record plastic waste under 100kgs (this was set to be fixed but not during the period of this research).



Figure 6. Differentiation between separated cardboard bin (pap) and separated cardboard and paper bin (pap og papir) provided by private waste management company Marius Pedersen (blue bins with slightly different sizes). Black bins provided by the Aalborg Municipality which mixes paper and cardboard in one bin (see bin on the right) and plastic and metal together in one bin (see bin on the left). The photos were taken by the author during the survey.

- 3. Much of the survey was answered by the workers who had limited information on the waste management system, such as whether the bins were shared with neighboring shops or residents above and which private waste company collected the waste. Since some of the shops utilized the bins provided by the Aalborg Municipality (which belonged to the residents living above the shops), it resulted in the mixing of the waste fractions, making it difficult to determine the shop's output. Therefore, only 37 out of the 64 (58%) surveys were completed surveys that could be utilized for the environmental impact analysis.
- 4. Data collection from the private waste management companies (i.e. Marius Pedersen and HCS) in terms of their quantity of waste fractions collected in the pedestrian streets was rejected on the basis that it would take a lot of time to separate these data and due to privacy issues. Therefore, generic qualitative data from the interview with the spokesperson from private waste management companies were utilized with a margin of error.
- 5. It is difficult to compare the CO₂ savings between the main three forms of transport utilized for waste collection and disposal. They are i) diesel trucks from the private/public sector, ii) the owners of the shops driving their own car to the recycling station and iii) electric vehicles from FleXskrald that drops off the waste at a central disposal area which is then taken away by the diesel truck. These three modes all have different distances (km) it covers and a different load of waste (kg) they have to haul. This means that despite the fact that a diesel refuse truck¹⁷ emits much more CO₂ per km, it can also carry a lot more load than the EVs used for FleXskrald, making it difficult to compare. Also, FleXskrald EVs and the

¹⁷ "The diesel consumption per ton of waste collected will depend on a range of factors related to the waste, the collection area, the truck, the distance to the unloading point, and the driver. The diesel consumption takes place during acceleration, driving and compaction of the waste. Several models predict diesel consumption during waste collection based on detailed information on a number of stops, number of bins per stop, the distance between stops, etc... Often the input parameters themselves are highly variable and hard to determine" (Larsen, Vrgoc, Christensen, & Lieberknecht, 2009).

refuse collection trucks have established routes and rounds whereas, the shop owners drive directly to the recycling stations, sometimes on the way home (which is distance (km) they would have driven regardless). There are also many other factors that come into play that complicates and makes the data less accurate such as driving methods, age of the vehicle (fuel efficiency) and taking into consideration lifecycle analysis of the electric vehicle's battery (i.e. lifespan of the batteries last, ethical material sources) in comparison to the lifecycle of a diesel truck.

6. It is hard to predict the expected impact of the FleXskrald project during or after its trial period of three years for various reasons: The current customers that have signed up may not exceed the free trial period of three months. This assumption is due to the interviews conducted from shop owners stating that they do not want to pay for this service or have the money to pay for them (esp. the small shops that have small revenues). Therefore, at this current stage in the project, it is difficult to predict the number of people who will sign up for FleXskrald and thus calculate its associated impacts. Furthermore, the FleXskrald model does not guarantee that the shop owners will recycle more as it is only a collection system, (though recycling is encouraged), which makes the impact calculation based on speculation of their future behavior.

Limitation on the researcher's speciality, as the social impact analysis requires deeper insight into social sciences and vocational psychology, which is beyond the scope of this project, but worthy of future investigations. Unfortunately, requests for interview and information with Stena received no response. This would have been useful data to gather to understand whether the contribution of FleXskrald's waste at the back of Salling and Føtex compressor containers (called *komprimator*¹⁸ in Danish) (see

7. Figure 7) would require another delivery load, thus impacting the CO₂ environmental calculations in Table 6. Additionally, Klaus Bro Brystrup (2019) from Aalborg Forsyning did not/could not provide the latest new recycling data post-2016 (set to be published) for the commercial sector which would indicate an increase in recycling amount in the commercial sector of Aalborg.



Figure 7. A typical waste compressor containers provided by Marius Pedersen (Marius Pedersen, n.d.-b).

¹⁸ Compressor containers are suitable for larger quantities of waste and are typically used for waste for incineration and cardboard but can also be used where there are large amounts of soft plastic. The container compactor presses the waste 3-4 times smaller than its original size depending on the nature of the waste (Marius Pedersen, n.d.-b).

4 Results

4.1 The role of CSR and SDG on FleXskrald for the private and public sector for the waste industry in Denmark

In order to understand the potential ramification of the three-year pilot project, one must delve into the reasoning behind why FleXskrald is motivated to incorporate social and environmental business model at its core, aiming to set an example to reduce potential negative impacts on the waste industry for both public and private sectors. Therefore, it aims for its business model to be adopted by the private waste management industry (or to other smaller cities) after its project completion. A possible avenue to exert influence on the private commercial recycling business can be achieved through understanding the private companies' Corporate Social Responsibility (CSR) to realize the motivations behind why these companies pursue environmental and social values as part of their core business operations.

4.1.1 What is CSR? The role of CSR on the Danish welfare state

To put it simply, the role of CSR is to bring forth the responsibility of corporations for their various impacts on society. Corporate Social Responsibility (CSR) is defined by The International Organization for Standardization (ISO) as:

"Responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behavior that: (i) contributes to sustainable development, including health and the welfare society; (ii) takes into account the expectations of stakeholders; (iii) is in compliance with applicable law and consistent with international norms of behavior; and (iv) is integrated throughout the organization and practiced in its relationships" (ISO, 2010).

The definition of CSR is continually evolving as it is embedded in political, social, cultural, economic and institutional contexts of its time and place (Wehmeier & Schultz, 2010). In order to support and ensure organizational accountability, CSR framework provides guidance to help outline rules and measures for organizational actions regarding social and environmental issues (Rasche, 2010). It achieves this by establishing "effective systems for setting standards, reporting, auditing monitoring and verification of CSR" (Scherer & Palazzo, 2011), as highlighted in international guidelines and standards that have been created to prevent continual green washing or merely paying lip service from corporations. These are: the UN Guidelines for Human Rights and Business and the OECD's guidelines for multinational companies but also UN's Global Compact, UN supported Principles for Responsible Investments (PRI), various ISO standards (i.e. ISO 9001, 14001, 26000) to name a few (Zinenko, 2014).

To understand the influential role of CSR in Denmark, one need not look further than the influence of the European Commission (EC). Particularly since 2001, it has played a pioneering role in the progress of public policy in Europe and to proactively endorse CSR. The EC further

strengthened its requirements on CSR on the 2011-2014 EU strategy such as working in close collaboration with stakeholders and have an internal process in place that integrates social, environmental, ethical and consumer concerns (European Commission, 2017; Zinenko, 2014). Due to the influence from the EC, CSR has had a various influence on the different EU member states, however, for a welfare state like Denmark, it has always had a different approach to capitalistic corporate business models with a stronger influence on social matters. Cooperation was regarded as a more important value than competition in Nordic corporate culture, thus, the role of the state was much more prominent (Mathis, 2008). Therefore, countries like Denmark has always been represented as leaders in driving progressive CSR initiatives due to having supportive national institutional frameworks that influenced the success of CSR (Gjølberg, 2009). Mostly, the Danish CSR is being claimed as an exclusive case for having low power distance in corporate culture with high levels of trust on government bodies and relatively egalitarian social structure for bringing the CSR agenda forward (Hofstede, Hofstede, & Minkov, 2010; Zinenko, 2014). This has an influencing role on leadership which is "highly influenced by the national cultural norms of work and the organizational culture in which they are embedded" (Hofstede, 2001). Therefore, it is of no surprise that Nordic companies are generally known for having a stronger commitment to international CSR initiatives, through "a close, cooperative and consensual relations between state, business and labor as well as a long-standing tradition for involving civil society in policy-making" (Gjølberg, 2009), with a relatively stricter environmental and social regulations to comply with (Zinenko, 2014). Since 2000, Denmark has enacted legal requirements for CSR reporting for Danish companies (dependent on size – usually large) by the Danish Financial Statements Act. This means, reporting on the company's employee relationships, social conditions and now operational environmental impacts as part of the overall reporting. (Erhvervsministeriet, 2015; Erhvervsstyrelsen, 2015). What this highlight is the importance of wider societal interest and general agreement for dialogue and cooperation in Denmark, which has successfully translated into supporting CSR from a regulatory, cultural and corporate level.

4.1.2 CSR for the private waste market company

The investigation into the cultural context and political institutional embeddedness of CSR in Danish corporate values, indicated that the private waste industry may already be forefront in environmental and social concerns FleXskrald project is trying to address. Therefore, by looking into the mandatory CSR reporting of the leading environmental waste management company Marius Pedersen Group, it may indicate what aspects of the CSR they are focused on and how they plan on meeting their goals. By investigating their CSR policies, this research aims to highlight any opportunities that FleXskrald could influence the private industry but also learn from.

Marius Pedersen Group's CSR report

The 2018 CSR report for Marius Pedersen Group (MPG) defines their primary objective to transform waste into a new and valuable resource to contribute towards the development of the

circular economy to reduce negative environmental impact. This means orientating the business model to reduce waste where possible and improve recycling (Marius Pedersen Holding A/S, 2018). For the MPG's Aalborg East branch, it provides services for waste collection, sorting and transportation. There is no recycling plant facility in this branch that makes new materials, therefore, the recyclable materials are transported to other plants and centers that allow bidders to purchase (both nationally and internationally) and process the recyclable waste for reproduction (Dreier, 2019).

Appropriate excerpts of the MPG's CSR report have been analyzed through supporting materials from the interview with the spokesperson for MPG in Table 2 below.

MPG CSR report excerpt	MPG Action	Applicability to
	(clarified from interview)	FleXskrald
1. "MPG takes responsibility for the recycling and recovery of the resources in the waste due to their business activities MPG encourages customers and business associates to choose systems or products that ensure maximum recycling and economize natural resources. MPG create visibility regarding customer's waste production and support optimum recycling in the service offered" (Marius Pedersen Holding A/S, 2018).	MPG informs its customers of, the best method for recycling and provides information materials and financial incentives to encourage recycling. One example is to charge their services based on weight and per minute it takes for the MPG worker to empty and sort the waste. However, this fee could be reduced by shop owners sorting their waste thus reducing the time for MPG staff to do, and also if it is recyclable material like paper/cardboard or plastic, the customer gets a certain percentage of the fee back, based on the current market rate prices for those recyclable waste. There is also visual training/ information material available for the shop owners/workers in order to encourage the correct procedures for sorting recyclable materials.	The financial incentive scheme provided by MPG, through reimbursing the shop/business customers a percentage of the market fee for recyclable waste may be a model that FleXskrald could adopt to increase recycling rate of their potential customer base, especially because the smaller shops that make up a big part of FleXskrald's customers cited unaffordability as one of the main reason for not using private recycling collection system (shop owners can even reduce the costs by sorting recyclable waste themselves). Perhaps an information brochure on the benefits and best way to recycle for the customers may also influence more customer engagement to recycle.

Table 2. Excerpts from CSR report by Marius Pedersen Group, its actions to CSR and applicability to FleXskrald (Dreier, 2019; Marius Pedersen Holding A/S, 2018)

2. "MPG has identified fuel (diesel) ¹⁹ and electricity as the	MPG is fully aware of their operational environmental	It appears that stronger influence could be exerted
main recourses being used	impact especially with regards to	from the Aalborg
during collection transport	the use of diesel Therefore	Municipality to implement
and handling of waste	electric refuse collection trucks	electrification of rofuse
and nanating of waste	have been purchased for A arbus	collection vehicles from a
	Coponhagon and Eshiorg but not	logislation perspective to
Since 2016 MPG has introduced	for A alborg yet. This is	event more influence on the
transport equipment which is	influenced by logislation and	decision molting process for
fully or partly driven by	demond from the local	decision-making process for
electricity instead of diesel	demand from the local	Ma Dela a
and this has been on the	municipanties in restricting	Marius Pedersen.
increase each year. Over the	diesel trucks in certain areas or	What it also highlights is
next years, Marius Pedersen	demanding electric refuse	the importance of other
Group will explore further in the	collection trucks.	factors that can reduce
area of alternative fuel types	Nevertheless, the "overall diesel	diesel consumption such as
like electricity or	consumption per ton of waste has	route optimization to
sustainable fuel and hence	been decreasing since 2016 due to	providing training for
substitute the use of	an increased focus on route	drivers for more fuel-
conventional diesel	planning and optimization, and	efficient driving through
The MPG's emission has a	investment in new equipment,	monitoring their driving
negative impact on the	introducing electricity as a	patterns.
climate and the	substitute for fuel, digitalization	Route optimization is
consumption of resources	to monitor driving patterns and	something that FleXskrald
for example diesel which leads	drivers trained in fuel-efficient	could adopt appropriately
to an emission of CO ₂ CO	driving" (Marius Pedersen	and apply insights from
NO and SO_2 " (Marius	Holding A/S, 2018).	MPG with years of
Poderson Holding Λ/S 2018)		experience in this field.
redersen fiolding A/S, 2018).		
3. <i>"The fuel consumption</i>	There is a dedicated department	FleXskrald may also benefit
represents more than 80% of the	at MPG to ensure new	from focusing on recycling
total CO_2 emission and hereby	technology, new methods are	waste that is currently
it is an area of great interest	integrated to ensure better	difficult for the
for future objectives and	solutions are implemented to	$\mathrm{shop}/\mathrm{business}$ owners.
plans for investment and	continuously work towards	Currently, FleXskrald is
improvement	reducing environmental impact.	planning to collect
Over the five-year period from	This can range from minimizing	Styrofoam from packaging,
2014 to 2018, there has been a	MPG's operational impact such	which normally would be
decrease in the total CO_2	as recycling materials that were	disposed of. It would be of
emission and hence a	not possible previously (i.e.	FleXskrald's best interest
reduction in environmental	organic waste is collected and	to investigate other

¹⁹ The consumption of diesel is the main environmental impact at Marius Pedersen Group and 90% of the total diesel consumption is used for the daily collection and transport of waste fractions from customers. The remaining 10% of diesel is used at the facilities for sorting and preparation of waste before recycling, energy recovery or landfilling at suitable and approved partners (Marius Pedersen Holding A/S, 2018).

<i>impact</i> " (Marius Pedersen Holding A/S, 2018).	turned into biogas or compost. It is currently collected in plastic bins but a new kind of plastic bag appropriate for organic waste is being tested). MPG has already attained ISO accreditation for its environmental operation (which needs to be renewed periodically).	specialized waste fraction generated from the shops/ businesses that could be recycled that currently is being disposed (i.e. organic waste) under its subscription model. It could target waste with smaller waste output that might be uneconomical for bigger private companies to collect
4. "MPG does not exercise discrimination due to various factors including disability. There should be no discrimination in the company and decisions for hiring should be assessed by relevant and objective criteria The company engages in a dialogue with municipalities and job centers with regard to job creation MPG harbors a cooperative relationship for example with its local municipality and other municipalities and regions where the company operates and tries to proactively to carry out its activities and operations in collaboration with these partners" (Marius Pedersen Holding A/S, 2018).	MPG in Aalborg has hired flex- jobbers before for various tasks. They intentionally try to incorporate flex-jobbers through their 'Business Network 9220' (Erhvervsnetværk 9220), which is a large collection of different companies and organizations to share information, provide support and collaborate. MPG supports a project from Business Network 9220 called, "Small jobs with meaning." (ErhvervsNetværk 9220, 2018), which provides access for companies to hire flex-jobbers. MPG collaborates with various stakeholders including the Aalborg Municipality and welcomes partnership with various enterprises.	Even though the 'Business Network 9220' is bound to companies with that postcode (i.e. Aalborg East), it is not strict. Perhaps, HVN could benefit from joining this network to collaborate further with many businesses, entrepreneurs, organizations, educational institutions, etc. to provide more opportunities for flex- jobbers and raise awareness of their social economy business model and the FleXskrald is already part of Network for Sustainable Business Development in Northern Denmark and Network for Green Detail).

4.1.3 Sustainable Development Goals – SDG Capture Dialog Tool Assessment

Another one of the crucial motivations behind FleXskrald is to address the United Nations' (UN) Sustainable Development Goals (SDG) to achieve a better and more sustainable future for Denmark and in particular, Northern Jutland. This motivation is fueled by the increasing importance of SDG that is predicted to become more widely spread and utilized in every avenue of development, with each SDG and targets set to be achieved by 2030 (United Nations, n.d.).

For the FleXskrald project, five relevant SDG were considered out of 17 that addresses the

challenges of inequality, climate action, environmental degradation, prosperity and sustainable communities as summarized in Table 3. The challenge is to integrate SDG in a way that localizes these global goals to a micro level suitable for the FleXskrald project. Therefore, the 'SDG Capture Dialog Tool' developed by NIRAS is utilized to show how the SDG can work as a communication tool to clarify and address various goals during different project stage and identify any new approach inspired by the SDG (NIRAS, 2019). Furthermore, the tool offers a systematic approach for the FleXskrald project to assess its potential to address some of the appropriate 17 SDG goals into actual initiatives and utilize it to monitor progress (NIRAS, 2019) (refer to Table 3).

Each corresponding SDG for the FleXskrald project was qualitatively assessed from a scale of six ranging from: major negative effect, minor negative effect, no effect, minor positive effect, medium positive effect to major positive effect on its expected impact from the FleXskrald project.

Table 3. NIRAS' SDG Capture Dialog Tool: Assessment of the five applicable SDG and its potential effect for the FleXskrald project (FleXskrald, 2019a; NIRAS, 2019; United Nations, n.d.)

Type of SDG	Definition	Application to FleXskrald
8 DECENT WORK AND ECONOMIC GROWTH	"Promote sustained, inclusive and productive employment and decen	sustainable economic growth, full and t work for all" (United Nations, n.d.).
TARGET 8·3	"Promote development-oriented	Minor positive effect
PROMOTE POLICIES TO SUPPORT JOB CREATION AND GROWING ENTERPRISES	policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro, small and medium- sized enterprises, including through access to financial services" (United Nations, n.d.).	Encouraging the growth of local small enterprises like Rezycl.com that utilize Information & Communication technology with its innovative website app and supporting medium enterprises like Huset Venture North Jutland via Innovation funding from the EU to create more jobs in the waste management sector. FleXskrald will provide a minimum 3 years of some revenue for these enterprises (co- funded).
TARGET 8.5	"By 2030, achieve full and	Medium positive effect
FULL EMPLOYMENT AND DECENT WORK WITH EQUAL PAY	productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value" (United Nations, n.d.).	Proactively hiring, paying market rate wages and providing HR/training support to four flex-jobbers who are either with a disability or/and is outside the traditional job market, in collaboration with Huset Venture North Jutland.

11 SUSTAINABLE CITIES	"Make cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, n.d.).		
TADOLT 44 C	"By 2030 reduce the adverse per	Medium positive effect	
REDUCE THE ENVIRONMENTAL IMPACT OF CITIES	capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management" (United Nations, n.d.).	Replacing diesel refuse collection trucks with EVs in the inner-city pedestrian streets to reduce air & noise pollution as a new waste management model in Aalborg. FleXskrald has the potential to increase livability in these areas with these initiatives.	
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	"Ensure sustainable consumption and production patterns" (United Nations, n.d.).		
TARGET 12.5	"By 2030, substantially reduce	Minor positive effect	
SUBSTANTIALLY REDUCE WASTE GENERATION	waste generation through prevention, reduction, recycling and reuse" (United Nations, n.d.).	Combat Denmark's increasing material footprint and its reliance on incineration by embracing circular economic principles focusing on recycling. Collect data to understand consumption patterns and inform better methods of recycling. Through the subscription system (not paying by weight) of FleXskrald, it has the potential to increase recycling from the service industry.	
TARGET 12.6	"Encourage companies,	Minor positive effect	
ENCOURAGE COMPANIES TO ADOPT SUSTAINABLE PRACTICES AND SUSTAINABILITY REPORTING	especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle" (United Nations, n.d.).	The major private waste management companies have sustainable practices and CSR reporting in place. Through the utilization of Rezycl app, crucial data can be gathered to provide information that could influence private companies to adopt sustainable practices for their CSR reporting. For e.g. FleXskrald could influence the early adoption of smaller EVs in Aalborg pedestrian streets to decrease CO_2 , air and noise pollution.	
13 CLIMATE	"Take urgent action to combat cli Natio	mate change and its impacts" (United ns, n.d.).	
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------	-------------------------------------------------	
TARGET 13·3	"Improve education, awareness-	Minor positive effect	
	raising and human and	Awareness could be raised through	
a the second sec	$institutional\ capacity\ on\ climate$	the active promotion of FleXskrald	
	change mitigation, adaptation,	services and its environmental and	
₼ .,, ^ , ^ , .	impact reduction and early	social goals to the shops/businesses in	
/U # T T M U	warning" (United Nations, n.d.).	Aalborg (and also through local	
BUILD KNOWLEDGE		media). Branding of SDG in	
AND CAPACITY TO MEET CLIMATE CHANGE		Flexskrald's EVs, posters, brochures,	
		website, social media etc. by graphic	
		Jutland could catch visual attention	
		among the public FleXskrald's	
		commitment and action towards	
		battling climate change via less	
		reliance on fossil fuels by embracing a	
		circular economy model.	
17 PARTNERSHIPS FOR THE GOALS	"Strengthen the means of imple	mentation and revitalize the Global	

Partnership for Sustainable Development" (United Nations, n.d.). Medium positive effect "Encourage and TARGET 17.17 promote effective public, public-private Collaborating with various actors and stakeholders (both from the private and civil society partnerships, building on the experience and and public sector) and form strong partnerships to achieve SDG. Coresourcing strategies of Partnerships" (United Nations, funded by the various stakeholders /partners with labor and money n.d.). ENCOURAGE EFFECTIVE PARTNERSHIPS (supplemented by the EU funding of 2.3 million Danish kroner).

An overview of the qualitative assessment indicates a potential minor to medium positive effect from FleXskrald's goals and activities. Since the project is still at its early stages with a limited customer base, it is hard to determine whether it will increase recycling rate hence reduce CO_2 . It's actual environmental or social benefits will need to be carefully monitored in the next three years (pilot period) to present a credible data to influence the private waste management industry, especially to see if there are any significant benefits from the FleXskrald business model as preassessed from this SDG Capture Dialog Tool.

4.2 Conclusion on CSR and SDG

- The presence of a stronger cultural, social, political influence of social consciousness and thus the importance of fulfilling CSR in Denmark, it may indicate a more malleable corporate environment to influence environmental and social agendas put forward by the FleXskrald model.
- The existing CSR requirement and SDG framework indicate a focus in reduction of environmental impacts, social consciousness and local partnerships already in line with FleXskrald's main objectives. The impacts indicated to be of minor to medium positive effect. However, FleXskrald could increase its impact by utilizing other strategies from the private industry (i.e. Marius Pedersen) such as expanding its waste fractions to include other forms of recyclable waste (i.e. organic) or to incorporate financial incentives scheme for the shop owners/businesses to increase recycling or to develop an educational material catered to different shops/businesses to help inform and raise awareness.
- Potential effect analysis of FleXskrald project from an SDG Capture Dialog Tool indicated the greatest effects are derived from: (medium positive effect)
 - Goal 8 Decent work and economic growth, Target 8.5 Full employment and decent work with equal pay,
 - Goal 11 Sustainable cities and communities, Target 11.6 Reduce the environmental impact of cities,
 - o Goal 17 Partnership for the goals, Target 17.17 Encouraging effective partnerships.
- The CSR reporting does not seem to further incorporate people that are vulnerable to society other than providing equal opportunity and pay for disabled people, nor a clause solely dedicated to flex-jobbers. This may be something that FleXskrald could offer a more proactive social model where the incorporation of flex-jobbers could be part of the company's social responsibility and identity, especially in the waste management sector.
- Many SDG targets focus on sustainable consumption and production rather than postconsumption which is what FleXskrald is concerned with (i.e. SDG target 8.4 Improve resource efficiency in consumption and production and target 12.2 Sustainable management and use of natural resources). This outlines a much bigger and broader emphasis on issues higher up in the waste hierarchy such as reduction, reuse and rethinking the way products are made.

4.3 Result of the survey of the current BAU behavior of shop/business owners in Aalborg's pedestrian streets

To understand the current business-as-usual behavior of the shop/business owner's waste disposal methods, 64 stores out of approximately 164 total of various size and types²⁰ were surveyed in the five main pedestrian streets in the Aalborg City Center during 18-19th of March (Monday-Tuesday) in the hours of 11 am to 4 pm (see Methodology Section 3.4.3 for more information). This survey was important to investigate in order to assess the potential environmental impact of the FleXskrald project. Out of the survey respondents, 31% was small shop owners, 42% medium and 27% large which indicates a reasonably even distribution of different sizes of shops (see Appendix B.2. for details). Of those 64 shops surveyed, 36% were retail clothing shops, 13% was food related, 8% were related to optometry services, 6% was related to mobile phone services, and equaling all at 5% were candy, books, shoes/sports, household goods and jewelry stores. The rest of the 16% of the stores range from the flower, audiovisual, pharmacy, supermarkets, beauty, hair and other medical services (see Appendix B.2 Figure 22 for more info). What this statistical analysis indicates is the type of waste produced due to the different activities of the stores. For example, the retail stores produced large amounts of cardboard and plastic packaging which were more likely to be recycled compared to food-related shops, which produces a lot of organic waste which was currently disposed of as municipal waste.

According to the survey conducted, private waste management company Marius Pedersen had the most well-established market presence²¹ for paper and cardboard waste as shown in Figure 8 at 37%, especially for shops that were part of franchises and well-established brands (Quintero Hansen & Schultz Andersen, 2019). It is followed by Aalborg Municipal residential bins at 22%. Fortunately, a majority of paper/cardboard waste ends up being recycled as indicated in Figure 9 at 94%. Contrastingly, only 34% of plastic waste gets recycled (as shown in Figure 9), and plastic that is not recycled usually ends up being mixed with the municipal waste bin fractions provided by the Aalborg Municipality, which results in their higher collection involvement of 48% for plastic, followed by Marius Pedersen at 23% (see Figure 8). This is because, many shops use the municipal waste bins provided by the Aalborg Municipality for the residents living above the shops, which results in approximately 15% of the residual waste generated from the shops that get disposed of as part of the residential waste²² (Grubb et al., 2018). This is the grey area of commercial waste

²⁰ See Appendix B.2. and Methodology Section 3.4.3 for more details. 20 shops rejected survey request. Therefore, approx. 39% out of the total shops were surveyed. Only 37 respondents were able to complete the whole survey providing details of the weight of cardboard/paper and plastic waste produced.

²¹ The surveyed figures are an underestimate of Marius Pedersen's dominance in the commercial waste collection market as many of the shops that rejected the survey or could not be surveyed were medium to large sized shops that most likely used their services.

 $^{^{22}}$ The total quantity of waste suitable for incineration from the households is mixed in with residual waste from the service industry which shares a lot of the waste collection routes. Therefore, they are all registered as household residual waste. An estimate from the Ministry of Environment and Food (Miljøstyrelsen) states, approximately 15% of residual waste from the service industry contribute towards the total household residual waste (Grubb et al., 2018).

recycling, as it is illegal for shop owners to dispose of the recyclable waste as part of residential waste. However, this is somewhat common practice (especially for plastic), as indicated by the survey and hard to track as the shops and residents share common back-of-house/utility areas, and many shop owners were not aware of the fact that they were not allowed to use the residential municipal bins.



Figure 8. Different ways paper/cardboard and plastic waste is collected/disposed of stores



Figure 9. Percentage of shops that recycle paper/cardboard and plastic waste

The most frequent collection schedule was once a week for both cardboard/paper and plastic followed by once every two weeks and once a month (See Figure 20 & Figure 21 in Appendix B.2.). Many shops claimed that they generate very little plastic waste and expressed sorting different types of plastic as a nuisance (see Appendix A.8. for interviews with shop owners) (Anonymous, 2019). Much of the plastic that does get recycled is plastic packaging from clothing retail shops that are usually put in a plastic bag without bins (see Appendix A.5. Figure 16). Shops also cited a lack of time to sort waste as a disincentive for recycling. These reasons all contribute towards the current behavior of different waste being mixed and not sorted, increasing the possibility that these waste fractions will get incinerated (Bro Bystrup, 2019; Hyldgaard, 2019). Additionally, most of the innercity shops do not even have proper recycling bins for their business and cite a lack of space for bins (see Figure 10), which could explain one of the reasons why plastic scores lower in recyclability due to its high percentage of 81% of unavailability of recycling bins.



Figure 10. Shops with access to paper/cardboard and plastic bins

FleXskrald can only target shop/business owners that currently do not have a waste collection service arrangement with private waste management companies. Majority of these shops are small to medium-sized shops ranging from under $50m^2$ to $100m^2$. Figure 8 indicates that a total of 44% of the shops/business does not use a private waste collection company for paper/cardboard disposal and 58% for plastic²³ (both overestimated figures).

Most shop owners reported sorting out their cardboard/paper waste for recycling, but it was not clear in some cases whether they dispose the plastic waste to be incinerated (småt brændbart)

 $^{^{23}}$ Both overestimated figures as larger shops that declined the survey requests were highly likely to have had an arrangement for waste collection from the private waste management companies (Quintero Hansen & Schultz Andersen, 2019).

at the recycling station. Moreover, only one shop owner acknowledged taking their shop waste home to be discarded as part of the household waste due to such a small amount of waste created. This behavior is more likely to be underestimated as this is an illegal practice.

Majority of the small shops that do not use the private waste collection service indicated affordability as the main issue, as some of the smaller shop owners do not feel they have enough revenue for small and irregular waste output²⁴. Furthermore, they also cited lack of space for bins and that they were too expensive. However, many shops cited efforts to reuse their cardboard and plastic packaging to reduce their waste output and big international brand shops cited a change in policy to replace plastic bags to paper bags (Anonymous, 2019).

Unfortunately, only 37 shops completed the survey out of 64 shops surveyed to give information on the average weight of plastic and cardboard/paper produced per week. For cardboard and paper, it totalled roughly 1,200kgs per week (approximately 32kg per shop per week, N=37) and a total of 600kg for plastic per week (approximately 16kg per shop per week, N=37) (Refer to Figure 24 and Figure 25 in Appendix B.2. for more information).

From the surveyed results, the current waste BAU behavior indicates the presence of a gap in the waste collection customer market for the inner-city shops that are not utilizing the preexisting private recyclable waste management companies. Thus, there is potential for FleXskrald to offer these businesses an alternative solution for the next three years to ensure that recyclable waste such as paper/cardboard and plastic are recycled in the most environmentally friendly way, but in hope to influence the shop/business owners to continue the practice of recycling after the completion of the project.

4.3.1 'Smart' waste initiative by Aalborg Forsyning

One of the initiatives that are in the five-year process of being implemented is the replacement of current bins (refer to Figure 3) to buried underground bins in the city center with smart sensors to streamline efficient waste collection along with awareness campaigns (Bro Bystrup, 2019). This is in line with Aalborg Municipalities' initiative called SMART Aalborg as part of the Smart City paradigm, which utilizes the use of new technologies, digitalization, data collection and Internet and Communication Technologies (ICT) to utilize limited resources in a smarter way to benefit both the environment and the citizens to transition into a more sustainable city (AAK, n.d.-b). This initiative will have an impact on the FleXskrald project as the Municipality will remove all the current wheelie bins from back-of-house areas (Bro Bystrup, 2019).

 $^{^{24}}$ Waste output is highly dependent on when the shops stock up on goods, usually with the change of season for clothing stores.

4.4 FleXskrald's role and impact: Environmental factors

Understanding the environmental impact of FleXskrald project is important as the EU's Structural Funds through the Smart Urban Innovation Call which requires public authorities to showcase their environmental reduction. The impact of their efforts must be on several innovative Small medium enterprises (SME) via 'smart' and sustainable solutions to the cities' environmental challenges (Erhverevsstyrelsen, 2016).

There are several avenues to calculate the potential environmental impact of the FleXskrald project. The most obvious is the CO₂ reduction from utilizing electric vehicles for waste collection²⁵ as opposed to the current business-as-usual (BAU) diesel garbage trucks utilized by the private waste management companies and the petrol-based cars used by shop owners to drive to the recycling stations. This, in turn, has an impact on the air and noise pollution which can also be estimated. Noise reduction due to the omission of diesel garbage trucks entering the pedestrian streets between the hours of 5-11am²⁶ in the morning can be further analyzed from the viewpoint of environmental psychology²⁷ and a broader discussion on increasing the quality of livability of cities due to a reduction in noise and air pollution from waste trucks.

Despite the fact that utilizing FleXskrald services does not necessarily guarantee an increase in recycling from the shop/business owners as it is only a collection service, there have been efforts to address other forms of waste that is not traditionally recycled. These are materials such as expanded polystyrene packaging due to the inquiries from the shop owners. As of three months into the FleXskrald project, it has been planned to be collected and recycled as part of the FleXskrald service (Quintero Hansen & Schultz Andersen, 2019).

Henceforth, potential recyclable waste fractions that could be diverted from incineration can be calculated as potential CO_2 savings from recycling. However, it is important to note that reduction in Greenhouse gas emissions (GHG) emissions due to recycling and electrification of refuse collection vehicles (RCV) only form one part of the environmental benefits. It is necessary to take other indicators into account, such as continuing resource depletion, energy use for extraction, manufacture and transport of raw materials, contribution to eutrophication and toxicity due to utilization of internal combustion engine vehicles and damage to wildlife (on plant and animal life) from continuing plastic pollution, as some of the key concerns to consider in order to get the complete picture of the impact (Hillman et al., 2015). This could, in turn, lead to additional reasons for climbing the circular economy ladder to close the loop in the waste hierarchy.

 $^{^{25}}$ However, the FleXskrald model would only be utilizing EVs in the city center of Aalborg to have the waste fractions dropped off in the central collection point as addressed in Figure 4.

²⁶ 5-11am is the official period that service vehicles are allowed access the pedestrian streets of Aalborg (Aalborg Kommune, n.d.-a; Bernth, 2019)

²⁷ Environmental psychology is an interdisciplinary field that emphases on the relationship between individuals and their environment. It investigates the way in which the physical environments impact our perception, emotions and actions (Gifford, 2012).

4.4.1 Incineration vs Recycling

Based on the survey data collected from 64 shops' current BAU behavior for waste disposal, 94% of the shops claimed to recycle paper/cardboard (3% is uncertain) as shown in Figure 9. This means that there is a potential for 3-6% of the paper/cardboard that is currently being incinerated that could be recycled. Studies conducted by Hillman et al. (2015) as shown in Table 4 investigates the GHG emissions from recycling and incineration. It is found that by recycling paper/cardboard material results in 6% in CO_{2-eq}/kg material in savings. This is rather a small reduction compared to the plastic, where there is a bigger potential for impact. The survey conducted shows that only 34% of the shops surveyed recycle plastic (3% uncertain). This indicates that there is 63%-66% of shops that dispose of plastic waste that could be recycled. This results in a 55% reduction in current CO_2 emissions from recycling plastic.

Table 4. Greenhouse gas emissions from recycling (secondary production and separate energy) and incineration (incineration and primary production), and comparisons between recycling and incineration. The unit used is kg CO_{2/equivalent}/kg material, and the material output is assumed to equal to the amount of treated waste (after losses), with the exception of organic waste (Hillman et al., 2015).

Material	Recycled:	Incineration:	Difference:	Ratio:	% variance:
	Secondary	Incineration	Recycling –	Incineration	Recycling
	+ energy	+ primary	incineration	/ recycling	vs.
	(kg CO_{2})	$(\mathrm{kg}\ \mathrm{CO}_{2})$	$(\mathrm{kg}\ \mathrm{CO}_{2})$		Incineration
	$_{ m eq.}/ m kg)$	$_{ m eq.}/ m kg)$	$_{ m eq.}/ m kg)$		
Plastic	2.2	4.9	-2.7	2.2	-55%
Paper and	1.1	1.2	-0.1	1.1	-6%
cardboard					
Organic waste	0.11	0.14	-0.03	1.3	-21%
(composting)					
Organic waste	0.07	0.16	-0.09	2.2	-54%
(digestion)					

Data from Hillman et al. (2015) indicates is the bigger CO_2 saving potential from recycling plastic and organic waste especially in the form of digestion (refer to Table 4). It is particularly important to increase commercial plastic recycling which has shown a low recycling rate in Aalborg. Organic waste collection service is already offered by private waste management companies (such as HCS, Marius Pedersen) (Bernth, 2019; Dreier, 2019).

Data collected from the survey and the study indicates is the attention required in increasing plastic recycling to reduce GHG emissions. Fortunately, recent efforts have been made in the past 2-3 years to increase recycling of plastic in Aalborg from the Municipalities. Despite its early implementation phase, plastic recycling is forecasted to increase over the next coming years (Bro Bystrup, 2019).

Therefore, FleXskrald would need to offer more variety in its services to collect other recyclable waste, such as the potential to introduce organic recycling option if it is to increase its

 CO_2 impact that is commonly produced by shops that are cafes and restaurants. Moreover, due to FleXskrald model is a subscription-based service where customers pay-per-collection rather than by weight, it may be in the interest to the shop owners to also include more of their plastic fraction (no matter how small). This could lead to an increase in recycling as opposed to disposing of them in the municipal waste bins. However, whether FleXskrald has an impact in changing the behavior of shop owners will become more apparent after the three-year pilot project and requires further investigation.

4.4.2 Diesel trucks, petrol cars vs electric van and moped²⁸

One of the key environmental concerns related to waste collection is due to the use and combustion of diesel as the primary fuel source in waste collection trucks. The associated CO₂ emissions due to the use of different fuel sources are thus investigated to compare the FleXskrald model to the BAU model of commercial waste collection. A study by L. H. Nielsen & Jørgensen (2000) compares the specific energy consumption and CO₂ emission for internal combustion engine vehicle (ICEV) and battery electric vehicles (BEV) for the two main Danish average vehicles of passenger cars and smaller delivery vans which are summed up in Table 5. It only considers the CO₂ emission in the overall energy system for the BEV's energy supplies that are based on electricity from the Danish grid (L. H. Nielsen & Jørgensen, 2000).

Table 5. Vehicle energy efficiency and specific CO_2 emission. Comparison for a defined average fleet vehicle of type ICEV and BEV. Power supply according to Energ21, The Plan scenario²⁹ (L. H. Nielsen &

	· · · · · · · · · · · · · · · · ·				
Type of vehicle Size: Average fleet	1997 - 2000	2005 - 2010	2025 - 2030		
ICEV Reference: $kWh_{(gasoline^{30})}/km$	<mark>0.66</mark>	0.55	0.55		
ICEV Reference: g CO ₂ /km	<mark>176</mark>	150	150		
BEV Reference: $kWh_{(electricity)}/km$	0.24	<mark>0.13</mark>	0.10		
BEV Reference: g CO ₂ /km	156	63	19		

Jørgensen, 2000)

From the data shown in Table 5, it is seen that fuel efficiency has improved since the '90s for both types of vehicles. The CO_2 savings between ICEV to BEV becomes significant as the technology of BEVs improve as shown in the figures in 2005-2010 of 58% reduction from ICEV and expected 87%

 $^{^{28}}$ The electric van is Nissan E-NV200 model is from 2015 with a lithium-ion battery. The TRIPL has a range of 100 km at 45km/hr, moves easily through car-free zones and has a loading capacity of 200kg/750L. The battery is lithium-ion with a full charge time of 8 hours (Quintero Hansen & Schultz Andersen, 2019; Tripl, n.d.)

²⁹ According to the Danish energy plan the decline of CO_2 emission per kWh of electricity delivered will continue. Calculations based on the expected development, according to Energy21, 'The Plan scenario' for the long-term development show 80% reduction in the specific CO_2 emission per kWh (192 g CO_2/kWh) electricity is expected for 2030 (L. H. Nielsen & Jørgensen, 2000).

³⁰ The fuel mix for the future ICEV fleet has been assumed to be 90% gasoline (on energy basis) and 10% diesel. This is close to the present fuel mix for this category of vehicles in Denmark, i.e. passenger cars and delivery vans of weight less than 2 tons (L. H. Nielsen & Jørgensen, 2000).

reduction from ICEV in 2025-2030. However, it should be noted, that the energy efficiencies of the ICEV and BEV as shown in Table 5 involve the different energy carriers of electricity and gasoline, thus comparing these energy efficiencies is not direct. Nevertheless, it indicates the attractiveness of the BEV from both an energy efficiency and CO₂ emission point of view compared to the conventional ICEV (L. H. Nielsen & Jørgensen, 2000).

Research by L. H. Nielsen & Jørgensen (2000) indicates is the potential of reducing CO₂ emissions from utilizing BEV as opposed to ICEV in the FleXskrald project. However, the limitation of this research by L. H. Nielsen & Jørgensen (2000) is that it does not take into consideration the larger fuel consumption for the diesel refuse collection trucks, than the smaller delivery truck model chosen for the study which would make a greater difference in CO₂ savings for the FleXskrald project. Nevertheless, it is clear that the higher fuel efficiency³¹ of the diesel waste trucks (ICEV) is required if GHG emissions are to decrease.

There may be further potential for CO_2 savings in switching to BEVs. Through the utilization of the smart-metering system to recharge BEVs during off-peak times, it can help smooth out demand and supply variability from renewable electricity sources, thus guaranteeing "greener" electricity (Sustainia, 2018; Vaughan, 2018). However, the case for BEVs is complicated as they require non-renewable and rare materials for its batteries such as lithium, cobalt, nickel and graphite, which its manufacture contributes towards its increase in emissions, along with other associated ethical and environmental problems³² (Oliveira et al., 2015). Nevertheless, other benefits from switching to BEVs such as preventing noise and air pollution could also be a supporting case for their use (refer to Section 4.4.4 and 4.4.5).

4.4.3 BAU vs. FleXskrald – Prevent incineration and diesel/petrol use

Only 37 shops out of the 64 completed the survey, giving an approximate account on their waste creation which is translated to per week basis (as this was the most common form of the collection). This smaller sample size³³ (N=37) was utilized to calculate the CO₂ impacts of recycling vs. incineration and the impacts of switching from diesel to electric. The different modes of disposal is divided into six groups (A-C)³⁴, ranging from i) shop owners that drive to the recycling station (to recycle and to incinerate), ii) shop owners that use the Aalborg Municipal bins with the residents (to recycle and to incinerate) and finally iii) shop owners that use the private waste management

³¹ As the newer emission standards from the EU tend to reduce the potential impact of acidification and nutrient enrichment, thus, its global warming potential becomes the most important environmental impact from combustion of diesel (Larsen et al., 2009)

 $^{^{32}}$ Child labor, resource conflicts, pollution associated with rare metal mining etc. (Asia News Monitor, 2019a, 2019b)

 $^{^{33}}$ There are approximately 164+ shops available on the main pedestrian streets of Aalborg city center.

³⁴ The final group that takes their waste home, only one shop owner admitted to doing so. Also, it is hard to estimate the various distances to the homes, and it is illegal to do so, therefore for the purpose of this calculation, it was omitted. However, there may be more shop owners engaging in this mode of disposal, but this data is difficult to capture as it has legal consequence.

companies (to recycle and to incinerate). FleXskrald's potential impact is shown in Table 6 below (for the corresponding co-efficient used to refer to Table 4 & 5).

Table 6. Three different modes of recyclable waste disposal. BAU vs FleXskrald by 37 shops that have fully
completed the survey (all figures are rounded to two decimal points). Refer to Figure 20 & Figure 21 in
Appendix B.2. for the weight (kg) per Group

Current BAU	Paper/cardboard Plastic		A new mode of
modes of disposal	Per week (BAU)	Per week (BAU)	disposal ($FleXskrald^{35}$)
Group A1: Use recycling station	Out of the 37 shops, none of the shop	Out of the 37 shops, none of the shop	No savings to be made by FleXskrald.
Not sorted – incinerated Drive by shop owners (petrol)	owners has stated that they dispose of paper/ cardboard for incineration. (However, out of the 64 shops surveyed 3% dispose their waste into the municipal waste for incineration)	owners has stated that they dispose of plastic for incineration. (However, out of the 64 shops surveyed 63% dispose their waste into the municipal waste for incineration)	
Group A2: Use recycling station	• 36.4 kg x 1.1^{36} = 40 kg CO_{2-eq.} is generated by 7 shops.	• $49 \text{kg x } 2.2^{26}$ = 108 kg CO _{2-eq.} is generated by 5 shops.	No reduction savings to be made by FleXskrald, as it is being recycled.
Sorted – Recycled	 4.2km (one way³⁷) x 0.66³⁸ x 7 shops' cars³⁹ = 19.4 kWh 4.2km (one way) x 0.176²⁸ x 7 shops' cars = 5.17 kg CO₂ 		Replaced by FleXskrald model of diesel trucks to Stena recycling center whilst FleXskrald's BEVs on the pedestrian streets: • 4.7km (one way ⁴⁰) x

³⁵ Tripl electric moped, designed in Denmark. Loading capacity (excl. driver) 200 kg. Loading volume trunk 750 liters. Lithium-ion battery. Fully charged in 8 hours. 100km range (Tripl, n.d.).

 $^{^{36}}$ See Table 4 for the appropriate co-efficient used.

³⁷ Based on assumption that the shop drivers park their near Salling department store (center of city) or nearby. It is not taking into consideration the possibility that these shop owners may be disposing their waste on the way back home, which would be distances they would be driving regardless. From Salling department store to Over Kæret Genbrugsplads is an average distance of approximately 4.2km.

 $^{^{38}}$ See Table 5 for the 1997-2000 co-efficient is used. This was used because the trucks tested on this study are 2ton trucks, whereas the refuse collection trucks are usually at 10t. Therefore, the worst-case scenario of 1997-2000 was chosen to compensate for the underestimated co-efficient.

 $^{^{39}~}$ The highest number of shop owners driving to recycling station was chosen out of cardboard/paper and plastic.

⁴⁰ Salling department store (central waste disposal point for FleXskrald) to Stena recycling center is approximately 4.7km. It is calculated under the assumption that FleXskrald's contribution to the shared waste compressor containers for Salling and Føtex does not require another load of delivery to be

Driven by shop owner's passenger cars/trailer (petrol)			0.66 x 1 tr = 3.1kWh • 1.5km (or 0.13 x 1 E' = 0.2 kWh Total = 3.3 83% CO ₂ re • 4.7km (or 0.176 x 1 t = 0.83 kg C • 1.5km (or 0.063 x 1 H = 0.09 kg C Total = 0.9 82% CO ₂ re	uck load diesel ne way ⁴¹) x V load electric kWh eduction ⁴² ne way ⁴⁰) x ruck load diesel CO_2 ne way ⁴¹) x EV load electric CO_2 2 kg CO_2 eduction ⁴²
Group B1: Use Aalborg Municipality bins	• 10 kg x 1.2 26 = 12 kg CO _{2-eq.} is generated by 1 shop.	• 275 kg x 4.9 26 =1,347 kg CO _{2-eq.} is generated by 15	Recycled: • 10 kg x 1.1^{26}	Recycled: • 275 kg x 2.2 ²⁶
(Household waste bins)		shops.		$\frac{=605 \text{kg}}{\text{CO}_{2\text{-eq}}}$ $\frac{55\% \text{ CO}_2}{\text{reduction}}$
Not sorted –				
	 7.7+1.5km (one wa load diesel 6.06 kWh 	y^{43}) x 0.66 ²⁸ x 1 truck	Assuming that waste truck is electric counte	the municipal replaced by an expart:
Driven by diesel municipal refuse collection trucks	 7.7+1.5km (one w truck load diesel 1.62 kg CO₂ 	ray ⁴³) x 0.176 ²⁸ x 1	$\begin{array}{c} 0.13^{28} \text{ x} \\ \text{electric} \end{array}$	1 truck load
			 1.5km (or 0.13²⁸ x electric) 0.2 kWh 	ne way ⁴¹) x (1 EV load

required.

 41 1.5km is approximately the total length of the pedestrian streets highlighted in red in Figure 2.

 42 Note: Assuming that the FleXskrald's contribution of waste to the waste compressor container for Salling/Føtex does not result in another load delivery for the truck, the high CO₂ reduction is due to the refuse collection truck headed for Stena Recycling Center carrier far more load than the average passenger car driven by a single shop owner.

 43 From Salling shopping department to Reno Nord (municipality owned recycling and waste disposal center) is approximately 7.7km.

			Total = 1.2 80% CO ₂ re • 7.7km (or 0.063 x (electric) = 0.49 kg C • 1.5km (or 0.063 x electric)	kWh eduction ne way ⁴³) x 1 truck load CO ₂ ne way ⁴¹) x (1 EV load
Group B2: Use Aalborg Municipality bins	190kg x 1.1 26 = 209 kg CO _{2-eq.} is generated by 7 shops.	29.8kg x 2.2 26 = 66 kg CO _{2-eq.} is generated by 5 shops.	$= 0.09 \text{ kg C}$ $\frac{\text{Total} = 0.5}{64\% \text{ CO}_2 \text{ re}}$ No reduction made by Flei is being recycl	8 kg CO ₂ 8 kg CO ₂ 9 eduction savings to be Xskrald, as it eled.
(paper-cardboard and plastic/metal bins) Sorted – Recycled Driven by diesel municipal refuse collection trucks	 Same as Group B1 7.7+1.5km (one way load diesel 6.06 kWh 7.7+1.5km (one way truck load diesel 1.62 kg CO₂ 	y ⁴³) x 0.66 ²⁸ x 1 truck ay ⁴³) x 0.176 ²⁸ x 1	Same as Gr $\frac{\text{Total} = 1.2}{80\% \text{ CO}_2 \text{ re}}$ $\frac{\text{Total} = 0.5}{64\% \text{ CO}_2 \text{ re}}$	oup B1 <u>kWh</u> <u>eduction</u> <u>8 kg CO₂</u> <u>eduction</u>
Group C1: Use Private company (småt brænbart)	 10kg x 1.2 ²⁶ = 12 kg CO_{2-eq} is generated by 1 shop. 	 75kg x 4.9 ²⁶ = 368 kg CO_{2-eq}, is generated by 5 shops. 	Recycled: • 10 kg x 1.1^{26} =11kg CO _{2-eq} <u>8% CO₂</u> reduction	Recycled: •75 kg x 2.2 26 =165kg CO _{2-eq} <u>55% CO₂</u> <u>reduction</u>
Not sorted – incinerated	 8.2+1.5km (one wa load diesel 6.4 kWh 8.2+1.5km (one wa load diesel 	$(y^{44}) \ge 0.66 \ge 1$ truck $(y^{44}) \ge 0.176 \ge 1$ truck	Assuming the companies' u replaced by counterpart: • 8.2km (or 0.13 x 1 tru = 1.1 kWh	t the private easte truck is an electric ne way ⁴⁴) x nck load _{electric}

 $^{^{44}}$ From Salling shopping department to Marius Pedersen's head quarters in Aalborg East is approximately $8.2{\rm km}.$

refuse collection	$= 1.71 \text{ kg CO}_2$		• 1.5 km (one way ⁴¹) x
trucks			$0.13 \ge 1 \text{ EV} \text{ load}_{\text{ electric}}$
			= 0.2 kWh
			${\rm \overline{Total}=1.3kWh}$
			80% savings
			• 8.2km (one way ⁴⁵) x
			0.063 x (1 truck load
			electric)
			$= 0.52 \mathrm{~kg~CO_2}$
			• 1.5km (one way ⁴¹) x
			0.063 x (1 EV load)
			electric)
			$= 0.09 \text{ kg CO}_2$
			$\underline{\text{Total} = 0.61 \text{ kg CO}_2}$
			<u>64% savings</u>
Group C2:	• 962.2 x 1.1 26	• $173 \ge 2.2^{-26}$	No reduction savings to be
Use Private company	=1,058 kg CO _{2-eq.}	= 381 kg CO _{2-eq} is	made by FleXskrald, as it
L Ž	is generated by 21	generated by 8 shops.	is being recycled.
Í	shops.		Sama an Grann Cl
Sorted – Recycled	Same as Group CI	45) 0.00 1.4 .1	Same as Group C1
	• $8.2+1.5$ km (one was	$(y^{40}) \ge 0.00 \ge 1$ truck	$T_{otol} = 1.9kWb$
29	-64 bWb		$\frac{10 \tan - 1.5 \text{KWII}}{80\%}$
Driven by diesel	= 0.4 KVII		<u>80% savings</u>
refuse collection	• 99+1 Flma (and and	$(176 \times 1 \times 1)$	$T_{otal} = 0.61 km CO$
trucks	• 0.2+1.5km (one wa	iy) x 0.170 x 1 truck	64% savings
	$-1.71 \text{ kg CO}_{\text{c}}$		<u>0470 Savings</u>
	<u>- 1.11 Ng 0.02</u>		

The main issue with this calculation is that the refuse collection trucks are not only driving for the load from the pedestrian street shops but also other parts of the city as well. Therefore, their overall CO_2 emission should be lower compared to the driving to recycling station by passenger car (petrol) – thus, this is not really a fair comparison. Nevertheless, what these calculations show is that by utilizing the electric moped and van from FleXskrald to replace the individual shop owners driving their own cars⁴⁶ to the recycling station could have a significant impact on fuel savings thus CO_2

 $^{^{45}}$ From Salling shopping department to Marius Pedersen's head quarters in Aalborg East is approximately 8.2km.

 $^{^{46}}$ The diesel truck may be more fuel intensive, therefore, generate higher CO₂ emission and kWh but

emission (this is not taking into consideration shop owners who are going to the recycling station on the way to/from home). It is clear that there is a reduction in CO_2 due to partial replacement with electric vehicles from FleXskrald, however, the savings will be very small due to the smaller distance it would cover (i.e. 1.5km) compared to the distances required to travel to the recycling center (i.e. 7.7-8.2km).

There is also the issue of inefficiency related to the increased man-hours needed to first collect waste from the shops, then another man-hour required to dispose the waste at the centralized loading dock at Salling compared to the big private RCVs where they only need to load and dispose of once. Additionally, more man hour is associated with giving the weight FleXskrald contributed to the Salling/Føtex Group for them to incorporate FlexSkrald's data. Increase in labor time for the FleXskrald model may challenge the CO_2 savings from electric vehicles if it requires a longer time to do the same amount of job (weight as a variable).

Furthermore, there are other CO₂ reductions associated with other factors such as fuelefficient driving skills, number of stops required etc. All of these factors make these calculations more difficult to compare with many discrepancies. Therefore, further investigation and more accurate data collection (of km and kg) are required to understand the impact of the FleXskrald's EVs in the pedestrian area and the impact of private and public refuse collection vehicles converting to an electric counterpart.

Finally, the sample data of N=37 shops cannot be a representation of the expected FleXskrald's customer base, as it is too early on in the project to estimate or know how many customers will sign up to the FleXskrald project.

4.4.4 Other forms of pollution from diesel trucks

The environmental impact from the current diesel refuse collection trucks used in Aalborg is not only dependent on the amount of fuel used but also on its contribution to the local air pollution. This is mainly due to the emission of exhaust gases from its combustion process. Additionally, it has other associated environmental issues such as oil spills, odour from the exhausts, as well as the energy and material required to manufacture and maintain these waste trucks and its collection bins (Larsen et al., 2009). Contrary to diesel trucks, the electric vehicles, in general, emit zero pollutants to the local air (L. H. Nielsen & Jørgensen, 2000). This fact forms a case for FleXskrald's utilization of electric vehicles for waste collection in the inner cities of Aalborg where many residents live.

A study conducted by Larsen, Vrgoc, Christensen, & Lieberknecht (2009) investigates the various impact categories of air pollution from diesel refuse collection vehicles $(\text{RCV})^{47}$ in the urban areas of Aarhus and Herning in Denmark. As shown in Figure 11, they were able to estimate the combustion emissions of carbon dioxide (CO₂ equivalents) for its global warming potential, sulphur

the truck carries a bigger load than a passenger car. Therefore, the equivalent trip done in a car is a lot less efficient than done in a truck per kg, because the truck carries far more waste.

 $^{^{47}}$ Gross truck weight: 10 tons (Larsen et al., 2009).

dioxide (SO₂ equivalents) for its impact on acidification, carbon monoxide (CO), hydrocarbons (C₂H₄ equivalents) for photochemical ozone formation, nitrogen oxides (NO₃ equivalents) for exasperating nutrient enrichment and particulate matter (PM) for being the main driver for causing grave health concerns. The emission of fine particles is considered to be detrimental to human health and can cause heart diseases, altered lung function and lung cancer (Larsen et al., 2009). PM_{2.5} accounts for about 93% of all premature deaths, O₃ for about 6%, NO₂ about 2% and SO₂ for less than 1% of all predicted premature deaths for Denmark (Ellermann et al., 2018). Fortunately, the total number of premature deaths from these pollutants are decreasing each year due to tighter regulations on ICEV as shown in Figure 11.



Figure 11. A total number of premature deaths due to PM_{2.5}, O₃ and SO₂ in Denmark as annual averages, due to the total air pollution (Ellermann et al., 2018).

Such regulations are demanding cleanness of the exhaust gas and limits for emissions from diesel trucks which is regulated by the European Emission Standards with increasing restrictions since 1992 (i.e. Euro V standard is for new trucks to meet by 2008). It has resulted in a noteworthy decrease of its potential environmental impact from stricter limit values for the emission of various harmful substances in Aarhus and Herning as shown in Figure 12 (Larsen et al., 2009).



Figure 12. Potential environmental impact from production and combustion of 1L diesel in a collection truck aggregated into four impact categories (for Denmark). The share below the line illustrates the impact related to production only⁴⁸ by a life-cycle assessment method (Larsen et al., 2009).

The inner-city center of Aalborg has demarcated Low Emission Zones (LEZ) including the pedestrian streets, which needs to comply with the EU air quality standards by reduction of ambient exposures to air pollution. It requires all diesel-powered vehicles above 3.5 tons since 2010 to meet the Euro IV standard or have a certified particulate filter fitted (Urban Access Regulations, n.d.). Furthermore, data collected in 2017 for Aalborg city center on the concentrations of Nitrogen Oxides, Particulate Matter, Heavy Metals, Ozone, Sulfur Dioxides as an average are below the annual mean limit set by the EU (Ellermann et al., 2018). However, air pollution measurements from sensors located on the busy inner-city roads in Aalborg like Vesterbro and Boulevarden that borders the pedestrian streets cite reported medium to high annual mean concentrations of air pollutants⁴⁹ (i.e. NO₂) (Ellermann et al., 2018).

These studies indicate that currently, Aalborg complies with the annual average EU air quality standards to ensure that the diesel refuse collection vehicles are of a standard that allows Aalborg to stay within safe air quality limit. Nevertheless, the argument for zero-emission vehicles should come from the goal to avoid harmful carcinogens from diesel RCVs and ICEVs in the first place, rather than trying to reduce them afterwards (Bates, 2018). This is especially because it has an impact on the quality of human health and livability of urban life (Silva & Mendes, 2012).

4.4.5 Sound reduction between diesel trucks, petrol cars vs electric cars

As a general rule of thumb, electric vehicles are quieter than the internal combustion engine vehicles

⁴⁸ "The global warming potential is constant because it is mainly caused by emission of CO_2 from the carbon content in the fuel." Therefore, global warming becomes the most consistent and persistent environmental impact from the combustion of diesel as other impacts are continually reduced from newer emission standards (Larsen et al., 2009).

⁴⁹ Particulate Matter critical to human health could not be measured in Aalborg from 2016 and 2017 because the station was closed temporarily due to construction work (Ellermann et al., 2018).

(ICEV) at low speeds, but not necessarily at high speeds. Therefore, by replacing the current diesel refuse collection vehicles (RCVs) driven at low speeds in the pedestrian streets of Aalborg with electric vehicles (EVs) could result in potential perceivable noise reduction (Marbjerg, 2013). An investigation carried out by Marbjerg (2013)⁵⁰ found that a typical diesel engine at 15km/hr has a sound level of 62.5dB and a typical electric car under 20km/hr has a sound level of 50dB which has an approximately 12dB difference. This is also congruent with noise reduction tests carried out in Table 7. The first and second column is the reduction in noise between electric passenger cars and ICE equivalent cars. The third column is the reduction in noise between heavy ICE vehicles to a heavy electric vehicle. Both are at a speed of 10km/hr from a distance of 7.5m from the source microphone (Marbjerg, 2013) which shows the potential sound level reduction of 10-15dB by replacing a diesel waste truck in Aalborg to FleXskrald's electric van/moped. Furthermore, the 7dB reduction can be achieved from replacing a petrol passenger cars of the shop owners who deliver their own waste to the recycling station to an EV used by FleXskrald (Marbjerg, 2013).

Table 7. The first and second column is the reduction in noise between electric passenger cars and ICE equivalent cars. The third column is the reduction in noise between heavy ICE vehicles to a heavy electric vehicle. Both are at a speed of 10km/hr from a distance of 7.5m from the source microphone (Marbjerg, 2013)

Electric passenger cars	Electric passenger cars	Heavy internal combustion	
and internal combustion	and internal combustion	engine vehicles and heavy	
engine cars (i.e. Diesel)	engine cars (i.e. Petrol)	electric vehicles	
15 dB	$7\mathrm{dB}$	$10 \mathrm{dB}$	

To understand the sound reduction achieved from switching to an EV that can be more perceptible to a real-life scenario, Table 8 lists the various sound levels of human activities and its environment. Sound levels in dB do not increase in a linear way, thus it is harder to perceive the difference in impact. The approximate 10dB reduction⁵¹ due to switching to an EV from say, 60dB to 50dB (as shown above by Marbjerg (2013)) is equivalent to the difference between the sound level of conversations in a restaurant to conversations in a dining room of a house (see Table 8). This may be the difference between a tolerable level of noise for people living above the shops especially during the early hours of 5-11am in the morning or it can be the source of annoyance to the residents decreasing the quality of livability in these areas (Marbjerg, 2013).

Table 8. Perceived levels of noise in dB of various human activities and environment (IAC Acoustics, 2019).

 $^{^{50}}$ This is closest data that is applicable for conditions present in the FleXskrald project where service vehicles that can access the pedestrian streets of Aalborg are only allowed to drive at very low speeds of below 15km/hr (Aalborg Kommune, n.d.-a).

⁵¹ However, these noise levels do not take into consideration other associated noises generated such as the compaction of waste, sound of breaking glass, the bin clashing noise, voices of the workers, etc.

Living room music (76 dB); radio or TV-audio, vacuum cleaner (70 dB).	70 dB	The upper 70s are annoyingly loud to some people.
Conversation in restaurant, office, background music, air conditioning unit at 30m.	60 dB	Half as loud as 70 dB. Fairly quiet.
Quiet suburb, conversation at home. Large electrical transformers at 30m.	50 dB	One-fourth as loud as 70 dB.
Library, bird calls (44 dB); lowest limit of urban ambient sound	40 dB	One-eighth as loud as 70 dB.
Quiet rural area.	30 dB	One-sixteenth as loud as 70 dB. Very Quiet.

Currently, there is no known investigation into the subjective experiences of residents living in the city center of Aalborg and their perceived level of annoyance due to noise associated with waste trucks or service vehicles entering the pedestrian streets during the hours of 5-11am. However, a study based in Utrecht, in the Netherlands investigated the reduction in annoyance levels of citizens who were annoyed by road traffic noise by replacing part of the ICEV fleets with EVs. Results showed that by replacing ICEVs with EVs gave a reduction of 33% of annoyed citizens and 36% reduction of severely annoyed citizens compared to the situation with no electric and hybrid vehicles (Marbjerg, 2013). However, the pedestrian streets of Aalborg do not have the same type of consistent traffic noise as Utrecht. Nevertheless, the study on Utrecht indicates the impact of the sound level reduction in urban areas and thus improving the quality of resident's lives resulting in a reduction of approximately one-third of perceived annoyance. Therefore, it is a useful intervention from the FleXskrald project to utilize the electric moped as a mobile sensor station to measure not only air pollution but also noise (since there are no emissions from the moped and is relatively quiet). Utilizing "smart" methods of data collection can help ensure that cities like Aalborg address, retain and improve on its quality working towards a better livable and sustainable city.

4.5 Case studies of similar projects in other cities

Electrification of the waste collection vehicles has already been trialled in cities like London, Hamburg, California, and several European and Chinese cities this year with plans for release in Brazilian and other American cities next year (Auto Business News, 2018; Messenger, 2018; Rolander, 2018). This is due to a recent technological breakthrough from several electric refuse collection vehicles (RCV) manufacturers such as Volvo, Daimler's Fuso brand and Tesla to follow its own release of heavy-duty trucks next year (Rolander, 2018). The competition to establish market dominance is due to the shift towards electrification in the automobile/trucking industry. This, in turn, is a result of the continuing decrease in the costs of operating battery-powered electric vehicles, forecasted to become the cheapest option by 2025, beating diesel and Liquified Natural Gas (LNG) fuel sources (Rolander, 2018). This is in line with the statement by Volvo's CEO, who predicts that "far more" than a quarter of trucks sold for city use is likely to run on electricity within five years (Rolander, 2018).

This recent trend of electrification is also due to the continuing reduction and elimination of the use of internal combustion engine vehicles (ICEV) in the coming years in many European cities to address climate change goals and to improve the livability of cities. For example, in the city of Hamburg, goals have been set to reduce carbon emissions by at least 80% by 2050, in addition, to significantly reduce municipal waste⁵². In 2019, Hamburg launched electrically powered garbage trucks from Volvo in order to achieve climate goals, reduce noise pollution and to improve air quality. Without the loud exhausts from a diesel truck, Volvo's electric trucks⁵³ can do their rounds in off-peak hours of early morning and evening to help reduce congestion. Hamburg has already introduced electric buses into its mobility plan and electric municipal cars, investing in electric vehicle recharging infrastructure (De Man, 2018; Waste 360 (Online), 2018).

Another example is from Denmark in Frederiksberg in Copenhagen in 2017, where a twoyear trial period has successfully completed the introduction of zero emissions RCVs, which were of conventional size and operated by a lithium-ion battery. The trial period indicated that despite operating 26 tons gross weight, the improved battery technology of the RCV had enough power and range to complete a normal shift contrary to initial doubts (Bates, 2018). The initial cost for electric RCV is double that of a conventional diesel-powered truck of the same capability, however, various tests of these electric RCVs show that operating costs are significantly less than those of comparable diesel-fueled vehicles especially with regards to tire wear and brake overhaul costs. Furthermore, the battery packs last at least 8 years (reaching 10 as a maximum) without significant reduction in performance (Bates, 2018). As the price of diesel rises and environmental regulations get tougher, it could justify its initial purchase costs. Currently the "break even" point is at 7 years, but this is expected to decrease over the years.

Another Nordic example is in a town called Sarpsborg in Norway with a population of 55,000. Sarpsborg is transitioning to a low carbon city. Since the start of 2018, Sarpsborg has reduced its fossil fuel use by replacing their diesel RCVs with a zero-emission electric counterpart (see Figure 13). However, Sarpsborg was already operating seven other existing RCVs fueled by biogas from a local plant prior to the electric RCVs. The clever use of biogas as a renewable energy source, which comes from the breakdown of the local municipal waste, completes the recycling 'circle' by utilizing it as fuel for the RCVs (Bates, 2018). The waste collection and recycling contract is managed by a top commercial waste contractor in Norway on behalf of the local municipality; in other words, a partnership between the private and the public sector. Furthermore, electrifying its

 $^{^{52}}$ Currently there are 300 diesel garbage trucks that emits approximately 31 tons of CO₂ into the atmosphere whilst collecting and disposing 27 tons of waste in the city of Hamburg which has a population of approximately 1.8 million (De Man, 2018; Waste 360 (Online), 2018)

 $^{^{53}}$ Volvo FE/FL electric truck models haul loads up to 10-15tons. It is a lithium-ion powered 100-300kWh battery, lasting 8-10 hours, range of 200-300km (Rolander, 2018; Waste 360 (Online), 2018)

RCVs has had a positive social impact on the workers and the residents, where the workers can now enjoy the conversations with other workers due to the quieter operation and the residents and shoppers have reacted positively to the reduction in noise on the streets (Bates, 2018). It is clear that Sarpsborg made an investment and decision to carry out zero emissions RCVs into service to improve the lives of its residents on the pedestrian streets in the town center as well as its environmental footprint.



Figure 13. The main traditional shopping pedestrian streets in downtown Sarpsborg, Norway to promote a quieter atmosphere by the clean electric RCVs. ©WEKA Industrie Medien GmbH (Bates, 2018).

All the above case studies are examples of conventional RCVs, which may be applicable information for the private waste management companies in replacing their current diesel trucks, however, FleXskrald utilizes smaller electric vehicles. Therefore, examples of smaller EVs were investigated. In the city of Utrecht in the Netherlands, the city wanted to tackle air pollution in the historic city center with narrow pedestrian streets from their internal combustion engine delivery trucks. These trucks were replaced by Alke's solar-powered electric vehicle called *CargoHopper*, which is a smaller model of a delivery van that can tow up to 3 tons of load with a maximum speed range of 20-33km/hr, designed to be used inside the historic city center (especially areas where the bigger trucks cannot enter) with maximum range of 60km per day (see Figure 14) (Alke, n.d.-b). The interesting part of this system is that since it is an electric delivery van, it can deliver goods and packages to shops inside the historic center (pedestrian streets) whilst taking back the "dry" waste such as cardboard, paper and empty packaging for recycling in order to take advantage of its return journey back to the truck unloading bays (centralized collection and drop off point). Therefore, Alke's EV reduces up to 100,000km of diesel and petrol vehicles inside the city center which equates to reducing 30 tons of CO₂ (Alke, n.d.-b). Other smaller EV models like Tripl and Alke have been utilized for a broad range of other uses such as garden ground maintenance, cleaning, waste collection, etc. for both in the private and public sector (Alke, n.d.-a; Tripl, n.d.).



Figure 14. Alke's solar powered EV 'CargoHopper' which can tow trailers to deliver goods (Alke, n.d.-b) What these case studies demonstrate is that the Scandinavian and Northern European countries committed to ensuring high air quality standards and responding to environmental responsibilities. There are genuine concerns with respect to the health impacts of diesel exhaust pollution, especially on the children. This has led to cities in Norway to order new zero-emissions RCVs as their mitigation strategy (Bates, 2018). What the case studies also indicate is the lack of long-term data as these initiatives are all less than a couple of years old. Therefore, it could present a case for FleXskrald to be an early adopter of this technology to understand its full impact in the years to come where electrification is predicted to become the norm. In the next 5-10 years, it will be crucial for these towns and cities to monitor and collect data on the performance of the electric EVs and use the new insights gained to improve its performance for the future. Moreover, the data collected from the case studies would be more useful for other private waste management companies who may be looking into replacing their current diesel trucks as the market increasingly demands them. The smaller electric moped Tripl and the van used by FleXskrald could be appropriate for European cities where there are many narrow and pedestrianized streets. Furthermore, electric trucks would be most useful in a densely populated area where the collection is most efficient, and it is also in these densely populated areas that electric trucks will have the biggest impact on the local air quality and on human health. Additionally, the delivery van model of utilizing the return journey by taking back packaging waste has also been suggested and supported by Bro Bystrup (2019) from Aalborg Forsyning. This is a model that FleXskrald could also adapt to make use of the EVs in various different ways to increase its impact.

Finally, the case for electrification of service vehicles in the city center is a great response to the increasing global trend of densification of cities and a paradigm shift in city planning towards increasing livability via strategies to pedestrianize streets (Sepe & Pitt, 2013).

4.6 Conclusion on environmental role and impact of FleXskrald

- More concentrated efforts from FleXskrald to increase plastic recycling is important since the paper/cardboard fraction is already being recycled at a high rate in Aalborg. Furthermore, paper/cardboard recycling has a small CO₂ reduction from diverting it from incineration.
- FleXskrald should investigate collecting organic waste with high CO₂ reduction potential and other waste fractions to increase its impact. There is potential for organic waste to be converted into biogas which could also be utilized by the waste management industry or for other uses.
- Replacing the current diesel RCVs would have a minor consequence on the overall air quality in Aalborg since its air pollution level is below the limit acceptable by the EU. However, since the RCVs are the major source of diesel emissions in cities, the argument should be to continually aim to replace ICEV (in this case RCVs) and lower air pollution emissions as much as possible since they contain carcinogens detrimental to human health.
- FleXskrald could play a role in the early transition to a Smart City paradigm by gathering "smart" data and efficiently manage resources through utilizing the electric moped as a sensor station to measure waste fractions, air and noise pollution.
- Noise reduction could be one of the key environmental impacts for the FleXskrald model due to its potential to improve the city's livability and opens up new possibilities such as improving the social aspects of their working conditions for truck workers (refer to Norway case study example). However, issues around noise pollution in Aalborg's pedestrian streets needs to be investigated further, especially if noise reduction is used as a case for private waste management companies to adopt electrification of their RCV.
- Other case studies show that electrification of RCVs has already been adopted in many other cities in the past few years indicating its growing popularity and a paradigm shift towards electrification in the waste management industry. This trend is also apparent in other public transport and is driven by city planners and government bodies to ban ICEV from city centers. Therefore, FleXskrald could be an early adopter of this technology in Northern Jutland demonstrating the global trend towards electrification.
- The learnings from the case study in Utrecht highlighted the suitability of smaller EVs for pedestrian streets, where it also utilizes centralized collection and drop-off point similar to the FleXskrald model. The electric delivery vans utilized in Utrecht takes advantage of its return journey by bringing back packaging waste, reducing further CO₂ through its efficient use. FleXskrald would benefit from adopting this model as a goods delivery van (or provide services other than waste collection) to further increase its environmental impact. Furthermore, the smaller EVs have the added benefit of delivering cargo inside a building without producing health-harming emissions which could be useful for many other purposes.
- As shown in Table 6, with calculations based from N=37 surveyed shops, it indicates that the biggest CO₂ reduction is achieved by having the private and public refuse collection trucks (i.e. from the private waste management companies like Marius Pedersen and the Aalborg Municipality) to replace their trucks to an equivalent electric counterpart. Therefore, it is critical for FleXskrald to be able to influence the private industry where most of the diesel fleets operate.

4.7 FleXskrald's role and impact: Social factors

This section will attempt to outline the role of Huset Venture North Jutland (HVN) and what it means for FleXskrald to incorporate flex-jobbers as part of the social impact analysis. As indicated in Section 4.1, the Corporate Social Responsibility reporting and the initial SDG impact analysis showed that the social components play a crucial role in meeting the values and goals set out by those two key frameworks.

The SDG analysis showed that FleXskrald had a higher score on the social impact of the project which is reflected in the partnership with HVN and the employment of flex-jobbers as the main workers. However, this is not always standard business practice, as social components are usually an overlooked aspect perhaps because the social impact is difficult to measure empirically and the standard positivist form of measurement on social impact produces limited information on something that is inherently complex to calculate (Schokkaert, Verhofstadt, & Ootegem, 2009). This issue divulges into the interdisciplinary field of social sciences and vocational psychology thus relevant key insights from academic journals from these fields will inform this investigation.

4.7.1 Meaningful job creation – Huset Venture North Jutland (HVN)

HVN works as a third-party intermediary that provides support, network and hiring for flex-jobbers. These people range from those who have had an accident that caused permanent injury that prevents them from continuing their previous work, to veterans with Post Traumatic Stress Disorder, to those with substance abuse problems, to those who have a mental disability that may allow them to work full time but with a lot more support (Sif Boddum & Sletting Fischer, 2019). The target group eligible for HVN's services are listed in Table 9, showing the hierarchy of varying degrees of severity of flex-jobbers in need of support. The main aim for HVN is to provide support and training for flex-jobbers and help them work their way up the hierarchy in order to eventually become independent on their own (i.e. the green group) (Sif Boddum & Sletting Fischer, 2019).

Furthermore, HVN provides recruitment and contracted labor services for private companies (e.g. IKEA) who may want to fulfil their CSR. The advantages of hiring flex-jobbers is that because they can only work for few hours a day, the company do not have the same legal obligations as full-time staff⁵⁴ and are always guaranteed access to a flex-jobbers for that shift (i.e. if one flex-jobber is sick, another available flex-jobber can take the shift). Furthermore, Human Resource (HR) support, such as conflict resolution and further training on certain jobs are provided by HVN (Sif Boddum & Sletting Fischer, 2019).

⁵⁴ Flex-jobbers are hired and paid by Huset Venture North Jutland. Flex-jobbers are contracted to work for private companies which in turn pays HVN who then pay the flex-jobbers. HVN receives funding from the government which ensures their business model remains market competitive (they charge extra 10% on the hourly rate to pay for their services). However, it is HVN's goal to be independent from government funding as this revenue is not guaranteed (Sif Boddum & Sletting Fischer, 2019).

Table 9. Hierarchy of flex-jobbers from those who are in the green zone (easy to cater for and ready to become independent) to red zone (difficult to cater for and requires lots of support and help from HVN). Translated from Danish (Sif Boddum & Sletting Fischer, 2019)

Hierarchy of those entitled to a flex-job

- Those who often become employed with access to many resources.
- Usually gets hired in the same company before doing a flex-job.
- Manages themselves with regards to job search.
- Is rarely or never on unemployment benefit (ledighedsydelse).
- Those who have more challenges and fewer resources.
- Needs help with the job search.
- Those who are either uneducated flex-jobbers or those who no longer can work in the
- Flex-jobbers who have been unemployed for a long period.
- Often has multiple problems which are both social, personal and/or physical.
- Has many issues that are difficult to cater for and accommodate.
- Has difficulty maintaining employment
- Has a need for support of a mentor
- Has many challenges and few resources
- Has massive issues that are difficult to cater for and accommodate.
- Often has both physical, psychological and social challenges
- On the border to be entitled to early retirement.

The waste collection industry provides an ideal working condition for flex-jobbers as the work can be broken down into tasks that can be accomplished within a few hours a day (such as waste collection, labelling of bins, washing of bins and trucks etc.). Both public and private waste collection/disposal sector have been known to employ these vulnerable people who are traditionally outside the job market as stated by HCS (private waste collection company) and Aalborg Forsyning (municipal waste management) (Bernth, 2019; Dreier, 2019). What this indicates is that the waste collection market is suitable for the further potential to proactively incorporate FleXskrald's model of utilizing HVN's or other similar services available in Denmark to provide more opportunities to hire those who belong to a more vulnerable aspect of society as part of fulfilling their CSR.

The potential societal impact of collaborating with the social economy enterprise to hire flex-jobbers is discussed below.

Labor with meaning – "REAL jobs for REAL people."

Within vocational psychology, "meaningful work generally refers to work that is significant, facilitates personal growth, and contributes to the greater good" (Steger, Dik, & Duffy, 2012). Past research trends in vocational psychology have often neglected the impact of meaningful work on the overall well-being of the workers (Allan et al., 2016). For example, meaningful work has been

associated with better life satisfaction, positive affect, and life meaning in addition to reduced levels of anxiety, aggression and depression (Steger et al., 2012). Studies by Rothausen & Henderson (2018) indicate that meaning-based, jobs focus on the "why" or purposes of work in the context of an individual in a community and social relations, rather than in the confines of the work organization⁵⁵ (Rothausen & Henderson, 2018). Their research indicates that work satisfaction needs to involve the wider impacts of the job on family, the standard of living, how the job facilitates expression and development of self-identity in one's wider community, and a sense of purpose. "*These facets are important to individuals, the practice of management, organizational design, and society*" (Rothausen & Henderson, 2018). Therefore, a meaningful job is influenced by the cultural and social context which it is embedded in. This introduces an aspect of subjectivity in defining what a meaningful job is to each individual, taking into consideration one's immediate cultural and social contexts.

As mentioned in the CSR section of this report, Denmark has a specific welfare context which on one hand provides a lot of support and help for those that are disadvantaged, whilst on the other hand, there exist social pressures for everyone to have a job (Brixen, 2017; Gudbrandsen, 2014). According to HVN, a significant part of the importance of having a job is embedded in the Danish cultural identity of oneself (Sif Boddum & Sletting Fischer, 2019). However, recent research looking into the increasing and on-going neo-liberalization of the Danish welfare state has provided empirical support for the fact that unemployment in Denmark is becoming increasingly characterized by negative experiences of self-blame and shame as well as leading to psychological conditions such as depression, anxiety, and stress (Brixen, 2017; Pultz & Teasdale, 2017). For instance, Sif Boddum & Sletting Fischer (2019), both representatives of HVN, mention people lying about having a job whilst being unemployed. Finally, there is also a significant pressure from the current Danish government to get people out of the lower tier of unemployment benefit (i.e. kontanthjælp) by limiting its access increasingly (Gudbrandsen, 2014; M. H. Nielsen, 2015), as for instance seen in case of the so-called unemployment benefit ceiling limiting access after a certain number of years (kontanthjælpsloft). The narrative of those that are unemployed (and on the lowest form of unemployment benefit) is thus changing from one of the people who are struggling that need help to describe those as abled people with inherent potential for work (Gudbrandsen, 2014; M. H. Nielsen, 2015).

Due to the subjective and philosophical nature of "meaningfulness", there is currently no official definition of *'meaningful job'* in Huset Venture. However, Sif Boddum & Sletting Fischer (2019) who work and manage flex-jobbers at HVN define meaningful jobs as: *"Real jobs for real people."* This particular response is informed by previous experiences of poorly orchestrated fictitious mock projects that people with disabilities undergo as part of work training by recruitment/job centers. These projects were seen to be demoralizing, as they treated people as if they were not capable (this sort of trials may work with people with very low cognitive abilities but not others).

⁵⁵ Whereas, "pleasure-based, job-related well-being could be characterized as satisfaction with the "what" and "how" of doing the work in the work organization" (Rothausen & Henderson, 2018).

Therefore, Sif Boddum & Sletting Fischer (2019) believe it is important to make it "real," by getting these people to work on real projects with actual clients to instil a sense of pride, responsibility and feeling of acknowledgement. Pride seems to indicate a key factor in deriving 'meaning' for flexjobbers. This view is further supported by Bro Bystrup (2019) from Aalborg Forsyning who emphasizes the sense of pride that was instilled in people with intellectual disability whose task was to put yellow heart bin stickers as part of the branding for the municipal waste bins. He continues,

"They (flex-jobbers with intellectual disability) were really proud of that sticker... they felt like they were a part of the city because they saw that symbol everywhere. They knew that everyone had a bin and that everyone had to dispose of their waste using those bins. So, they felt what they did was important."

This view is also supported by interviews with flex-jobbers for FleXskrald project. One flex-jobber says:

"A meaningful job is a job where it is also fun to go to work and where there is a need for me. It is a job that I can make a difference by being able to contribute and make an impact." (Huset Venture Nordjylland, 2019)

Working for FleXskrald involves contribution towards a positive improvement for the environment through the act of recycling. This gave a sense of pride and civic responsibility for the flex-jobbers who stated their experience working for FleXskrald as being flexible, fun whilst being able to do something good for the environment. Working for FleXskrald as a flex-jobber has been different from other flex-jobs they have had in the past. Therefore, they expressed a desire for this project to continue after its trial period. However, they also emphasized the importance of having access to a job as a person who cannot work have a traditional full time. As one flex-jobber states:

"It means everything for me to have a job. I get happier, have better finances and am much more content. In my life, that means everything..." (Huset Venture Nordjylland, 2019).

It seems that the sheer fact of having a job can be regarded as a meaningful job in a social, cultural and political context that derives *having a job* with self-identity and happiness, more than *having a "meaningful job"* that one derives a sense of pleasure and purpose.

This coincides with other success stories from HVN, which mentions flex-jobbers who were able to find happiness and meaning in life by transitioning from being in a position of dependence (i.e. red and yellow group) with long periods of unemployment, to one of independence (i.e. green group) (Sif Boddum & Sletting Fischer, 2019). Therefore, the importance of being employed for the flex-jobbers seems to be a critical component in viewing the job as being "meaningful" in addition to finding meaning in the role of the job itself (e.g. by contributing towards a greater good).

Marius Pedersen have also accounted hiring flex-jobbers who have previously been suffering from high levels of stress and was temporarily employed to do non-stressful tasks, to give the flexjobber a reason to "get up in the morning", to afford a sense of social connection, and as a testing ground to see if the flex-jobber was ready for the full-time employment again (Dreier, 2019).

All of the aforementioned factors contribute towards the importance of having a job in Denmark and how it may affect not only your financial situation but also your social standing, giving people a sense of pride, purpose and happiness. Fortunately, many big companies in Denmark are recognizing those who are on the fringes of society and getting involved to incorporate flex-jobbers into employment (Dreier, 2019). It may be influenced by the growing popularity of CSR in Aalborg and in Denmark, as no company wants to be left behind (Sif Boddum & Sletting Fischer, 2019). Therefore, utilizing the FleXskrald project or working with HVN would be the easiest way to achieve CSR for many companies (Sif Boddum & Sletting Fischer, 2019). Furthermore, the new framework of targeting SDGs are also becoming a normative practice, which is putting pressure on companies to stay on track and show its compliance. Customers will start to demand compliance with SDGs, which in turn will be beneficial for the city of Aalborg as it pushes companies to minimize environmental impact and increase positive social impact (Sif Boddum & Sletting Fischer, 2019).

The value of local partnerships

Recently, the FleXskrald made it into the local newspapers for their contribution to deliver secondhand donated clothing to recycle, in a town called Vodskov (see Figure 15). This is a good way of building social relations with other organizations that could also help market and raise awareness about FleXskrald's environmental and social impact. Additionally, by collaborating outside the FleXskrald's normal operation of waste collection may also enhance the flex-jobbers sense of responsibility and pride for the "greater good" of the community. Furthermore, other positive social impact is derived from the partnership with a social economy enterprise such as Huset Venture North Jutland, Rezycl and AAU. For example, through the partnership with FleXskrald HVN would be getting more exposure of the important social work they do to the general public, who may not be aware of the support that exists for people who are outside the fringes of society (Sif Boddum & Sletting Fischer, 2019). This could be difference between someone having access to HVN's services that could lead to a flex-job and eventually working up the ladder of independence⁵⁶ to having no access to a flex-job.

Tøj-indsamlingen satte rekord med 237,85 kg.



Figure 15. Local newspaper highlighting a local initiative to recycle textiles and mobile phones. The title reads: "The clothing collection sets a record of 237.85kg" (Vodskov Avis, 2019)

⁵⁶ "People that are categorized under the "red" group usually take approx. 6months to a year to get them on their feet to find a job, but for mild clients with fewer disabilities (i.e. Green group) takes on average about 13 weeks for them to be able to work." Refer to Table 9 (Sif Boddum & Sletting Fischer, 2019).

4.8 Conclusion on the social role & impact of FleXskrald

- The waste management industry is very well suited for flex-jobbers due to the nature of the work which can require only a few hours. This presents a good opportunity for more proactive incorporations with flex-jobbers and a stronger role which HVN can play in assisting this industry. Therefore, the proactive promotion of the social component of the FleXskrald model is important to provide more employment opportunities for flex-jobbers in the region.
- Further research can be conducted after the trial period to understand the further impact it may have had on the flex-jobbers who worked for FleXskrald for three years. A possible impact could be the flex-jobbers moving up the hierarchy of independence (refer to Table 9) by having an easier time finding future job opportunities in the future.
- Due to the complexity of assessing the positive social/psychological impact from working on a flex-job in the Danish context, interdisciplinary research could be conducted to further understand this phenomenon (this may range from deterring people from going back to long periods of unemployment, depression, crime, substance abuse etc.). This could truly give insights into the benefits of FleXskrald's partnership with HVN and other similar local initiatives that surrounds the idea of, *"small jobs with meaning."*
- It is paramount for FleXskrald to continue to extend its services outside of waste collection if it is to make a maximum impact within its trial period. It is important that FleXskrald diversifies and emphasizes its work with the local community/partnerships as indicated by the example in Vodskov (refer to Figure 15), which can be extended to other cities, charities, organizations, initiatives etc. These "other" works can be further complemented by coupling awareness raising agendas such as the environmental and social impact associated with the FleXskrald project mentioned in this report.
- Studies show that an individual's definition of a meaningful job can be influenced by various factors outside the immediate confines of the job. Therefore, it is important to take into consideration the flex-jobbers' social, cultural, economic and political context. In Denmark where job employment pressure exists (influenced by increasing neo-liberalization of the welfare model) on a social and political level, this has an influence on the flex-jobbers sense of wellbeing, self-identity and their own definition of meaningful work. Hence, employment in itself plays a huge factor in deriving meaning and overall level of happiness. What this means is the importance of projects like FleXskrald to provide as many job opportunities as possible for flex-jobbers and should be recognized for its contribution to its attempt at social inclusion of them.
- For the individual flex-jobbers working for FleXskrald reported high levels of job satisfaction, which was partly due to the fact of having a job whilst complimented by a sense of purpose, pride and thus meaning derived from contributing to a greater good, in this case, the environment. However, further job satisfaction and meaningfulness could be studied among other flex-jobbers (outside FleXskrald) to draw a more accurate and consistent conclusion from the social impact of flex-jobs in Denmark.

5 Discussion

"FleXskrald is really a success if the existing private waste collection companies incorporate the concept further after the project expires." (Brauer, 2019; CSR.dk, 2019) Quote from Martin Quintero Hansen from Center for Green Transition, Aalborg Municipality, with the aim of signing up 50 stores during the project duration of three years.

The current business-as-usual linear model of economic development has been acknowledged to be an unsustainable model for the future. It contributes towards an inefficient and environmentally destructive practice of mining finite resources at enormous amounts, powered by fossil fuels to convert raw materials into consumable products that are distributed, to eventually end up in the landfill or incinerated for energy and heat but never to be utilized again nor create another value.

This chapter attempts to identify and critically discuss the research findings of the potential environmental and social impact associated with the FleXskrald project in Aalborg.

5.1 Key research findings

Here is the summary of this research's key findings:

Environmental impact

The findings of this research indicated the associated potential environmental impact to be:

- 58% CO₂ reduction⁵⁷ potential from utilizing electric vehicles (EVs) for waste collection from the potential customer target group which would be replacing petrol-based passenger cars for the car models between 2005-2010 (and from possibly reduced collection frequency of diesel refuse collection vehicle from Aalborg Municipality).
- 2. 6% CO₂ reduction⁵⁸ potential from diverting paper/cardboard waste from incineration and 55% CO₂ reduction⁵⁴ potential from diverting plastic waste from incineration.
- 3. 10dB of potential reduction⁵⁹ in noise level from replacing current diesel reduce collection vehicles (RCVs) with EVs, thus potential reduction of 33% in "annoyance" levels of residents living on the pedestrian streets above the shops (in the condition that the current private waste management and Aalborg Municipality diesel RCVs are replaced by electric counterpart).
- 4. A case for reduction in air pollution⁶⁰ in Aalborg's inner cities from diesel trucks that contains carcinogenic substances that are detrimental to human health (in the condition that the current diesel RCVs operated by the private waste management companies and Aalborg

 $^{^{57}}$ Figures based on research by L. H. Nielsen & Jørgensen (2000)

⁵⁸ Figures based on research by Hillman, Damgaard, Eriksson, Jonsson, & Fluck (2015).

 $^{^{59}}$ Figures based on research by Marbjerg (2013).

⁶⁰ Based on research by Ellermann et al., 2018; Larsen, Vrgoc, Christensen, & Lieberknecht (2009).

Municipality is replaced by electric counterparts).

The findings of this research recommend the following opportunities to increase FleXskrald's environmental impact:

- 1. To include other recyclable waste fractions such as organic waste which has the potential of reducing CO₂ by 21-54% from recycling as opposed to the current practice of incineration. Additionally, to focus more efforts on increasing the current low level of plastic recycling.
- 2. To utilize the FleXskrald EVs in other ways, such as for delivery of goods to take back packaging waste material back to the manufacturer.

Social impact

The findings of this research indicated the associated potential social impact to be:

- 1. The flex-jobbers working for the FleXskrald project reported high levels of job satisfaction, in particular, due to being able to contribute towards the environment and having a job. In the Danish context, this has a huge impact on the overall well-being and self-identity of flexjobbers to have a job due to the increasing social and political pressure.
- 2. There is a potential for flex-jobbers to progress from a position of dependence on HVN's support to a higher level of independence through the work experiences gained through FleXskrald, especially with regards to attaining future job opportunities.

The findings of this research recommend the following opportunities to increase FleXskrald's social impact:

- 1. Importance of extending FleXskrald's services outside waste collection to continue to get involved with the local community to raise awareness of the project and increase its impact, but to also provide more opportunities for flex-jobbers to contribute towards a 'greater good.'
- 2. The waste industry is well suited for flex-jobs, presenting an ideal opportunity for proactive incorporation of flex-jobbers to create more jobs in the industry through CSR.

5.2 Future research directions

The main research gaps in this research are summarized and translated into a future research agenda below.

Beyond recycling – Climbing the ladder of circular economy

Unfortunately, the FleXskrald model cannot encompass every step of the circular economic ladder. Currently, its focus is on recycling, remaining at the bottom of the hierarchy of the circular economy. Nevertheless, recycling is important, especially to help transition away from relying on incineration. However, recycling is a limited answer to a much bigger problem, which is the whole manufacturing system of consumable products, including everything from conception to delivery. Therefore, a holistic solution needs to involve all the stakeholders and actors in the broader industry and need to work collaboratively towards a better solution for the future that includes every step of the process of the material's life. As such, there is a future scope for research that involves the shop owners to be part of the waste management process, i.e. not only to be masters of disposing of their waste but also to find new and creative ways to reuse and reduce. For example, the giant clothing retailer H&M is implementing paper bags to replace plastic bags and reusing plastic packaging materials. Another unexplored question is the investigation of how to change the behaviors of shop owners to care more about waste reduction, reuse and recycling from other perspectives beyond affordability. Finally, future research could explore how to make this holistic processes such as LEAN and Cradle-to-cradle models where it takes into consideration the whole life cycle of materials from conception to end, into a good business model that could find market success in current times to drive the transition to a circular economy.

Other applications - Private waste management industry and other cities in North Jutland

This research paper could not gather data from the private waste industry, which holds more accurate data on the current waste disposal behavior of the shops/businesses on the pedestrian streets of Aalborg. There is research scope to calculate the potential environmental impacts from converting current clients who only have bins for incineration, into recycling (i.e. cardboard, paper, plastic, metal, glass, organic etc). Furthermore, there are impact calculations that can also be done with the private industries' data, such as the time spent on unloading and loading of bins to understand and compare efficiency of operation between for instance Marius Pedersen's automized truck and the workers vs. the FleXskrald method, which involves a lot more hand-over time (i.e. smaller haul/load capacity, the need to dispose the waste once more into Salling/Føtex's compressor bins, and more admin work associated with having to report weight of waste contribution to Salling). This information could be utilized to understand if FleXskrald is worthy of adoption for the private sector, who's a business model is based on streamlining and maximizing efficiency. Furthermore, more accurate real-life BAU data of shop/business' waste activities could be collected from other smaller cities in North Jutland such as Vodskov, Nibe, Svenstrup etc. to see if there is scope for FleXskrald's intervention.

'Smart' Data collection

During the three years of the pilot project, it will be critical to understanding whether FleXskrald's services has increased the level of recycling on the pedestrian streets of Aalborg city center. This may be achieved through consistent monitoring, review and analysis of data collected from Rezycl.com. Another innovative aspect of FleXskrald is to utilize the electric moped as a mobile sensor station to measure local air pollution and noise levels. This is ideal since the Tripl electric moped makes very little noise and has zero emissions. Currently, Aalborg does not have air pollution sensors on the pedestrian streets which border the main traffic roads of Vesterbro and Boulevarden. These two main roads have been found to have higher levels of air pollutants (Ellermann et al.,

2018). This data could be critical to assess and to investigate whether there is a case to support the electrification of service vehicles in the pedestrian zones on the basis of eliminating harmful air pollution (such as Particular Matter). Additionally, there are no surveys or investigations of the experiences of residents that live above the shops and their perceived levels of annoyance due to the presence of diesel refuse collection trucks and service vehicles early hours of the morning.

Within the next few years, 'Smart Waste' management based on the principles of Smart Cities are planned to be implemented by the Aalborg Municipality through the utilization of sensor technologies to collect data and streamline waste management to be as efficient as possible (i.e. sensors on buried bins allowing the trucks to pick it up when it is full, thereby optimizing routes and efficiency). Future research scope may need to consider and ask how digitalization and increasing automation will impact the longevity of the FleXskrald model and continue to provide opportunities for flex-jobbers.

Other waste fractions

The FleXskrald model currently only collects cardboard/paper and plastic, but the project needs to identify other potential fractions such as textiles, batteries, printer protons, pallets, organic waste, etc. (Brauer, 2019; CSR.dk, 2019). As indicated by Table 4, there is great potential to reduce CO_2 from organic waste recycling. There is even further potential to turn organic waste into biogas which can be utilized to fuel the RCV, as seen in the case study from Norway. There is a lot of scope for FleXskrald to investigate the myriad of waste outputs generated from the different shops/businesses to understand if other waste fractions such as textiles can be recycled. This research would need to be supplemented by surveys with the shop/business owners to understand their needs and interest.

$Meaningful \ job \ creation \ for \ flex-jobbers \ - \ Interdisciplinary \ approach$

This research attempted to understand and define what a 'meaningful job' might be for flex-jobbers in North Jutland, which is dependent on a complex relationship between its social, cultural, economic and political context. Due to the influence of one's immediate context, it is important to understand what 'a meaningful job' means for the flex-jobbers of Aalborg before promoting it as a marketing tagline. Therefore, it is critical for any future research to be conducted in an interdisciplinary manner, involving occupational psychologists, sociologists, philosophers, political scientists, as well as people from the recruitment industry and human resources specializing in dealing with flex-jobbers. This investigation will be critical to answering the whys and the how's of meaningful jobs through flex-jobs and how it can impact societal change for the most vulnerable people. Furthermore, it can correctly inform the corporate sector the full implications of the effects of "small but meaningful jobs" before incorporating it into their CSR report.

Triple bottom line – Economic impact

The current research has emphasized the environmental and social impact of FleXskrald. However, it is also important to consider the economic implications of continued resource depletion through the reliance on incineration (presenting a stronger case for recycling), associated energy required for raw material extraction, and environmental degradation/pollution associated with the manufacturing processes. The continued cost escalation of these raw materials will have an economic implication as impacts of climate change drive scarcity of materials and thus fuel demand. Furthermore, there will be a continuous rise in the cost associated with pollution, for example, plastics and microplastics which are difficult to eliminate once it is released into the environment. The cost of these damages to the environment is not just a financial one but also to human health. This has been particularly relevant with the continual usage of diesel vehicles and other ICEVs.

On the upside, there will also be an economic implication associated with new jobs created in the waste sector due to an increase in recycling, with governments investing millions towards the transition to a circular economy. Through new job creation in this industry, there is an economic impact from helping flex-jobbers (by hiring vulnerable people from the periphery of the labor market) from unemployment, depression, substance abuse, crime, etc. Despite the limitations and simplicity of translating employment of flex-jobbers in purely monetary terms, there are financial savings associated with deferring unemployment state benefits and gaining tax revenue from their employment. The economic impact of the FleXskrald is the third component of what is commonly known as the Triple-Bottom-Line framework, which has the scope for a future investigation.

6 Conclusion

This section discusses the key findings of the study with respect to the research question, identifying the most important issues.

Circular Economy and Smart data

We need to make the city's waste valuable again through the smarter and cleaner waste collection. That would enhance the livability of neighbourhoods and it would help us increase our reuse of waste. As exemplified by the data collection app provided by Rezycl.com, smart technology can and should be a part of this transition, as it enables transparency, measurements, and management that may catalyze the efficiency and make the visible novel the affordances and challenged currently faced by the current waste management sector.

Socio-psychological impact of the flex-job model

Another key insight of the study is the socio-psychological value that employment brings about in the contemporary Danish context. Currently, the Danish socio-democratic welfare model is undergoing changes due to the increasing implementation of neoliberal policies, and new research has tied these changes to a shift in the experience of unemployment, which shows that the selfreported subjective well-being amongst young and older unemployed people are significantly lower than those with employment. These concerns are reflected in the work of HVN, a practice unique to Denmark, who works toward rehabilitation through access to meaningful jobs. By offering support to climb the independency hierarchy from red to green, HVN affords critical benefits for those at the periphery of the job market. This socio-ethical practice shows promise in terms of its integration into the CSR of the companies in the waste industry.

The paradigm shift towards electrification and zero emission

Globally, a paradigm shift in the waste sector is underway toward transforming the BAU toward increasing electrification and zero emission, a transition that is reflected in mobilities in general. This shift is visible in the statement by Volvo's CEO, who predicts that "far more" than a quarter of trucks sold for city use is likely to run on electricity within five years (Rolander, 2018). This recent trend of electrification is also due to the continuing reduction and elimination of the use of internal combustion engine vehicles (ICEV) in the coming years in many European cities to address climate change goals and to improve the livability of cities. However, the insights provided by this research reveal that the private industry exhibits a certain resistance toward this idea, as the current business model by the private industry is driven first and foremost by efficiency, rather than investing a high-capital cost into the early adoption of new green technologies. The research also shows that this view remains untenable in the long run, as the price of diesel rises and environmental regulations get tougher. It suggests justifying the initial purchase costs with reference to the currently diminishing 7 years of "break even". Within the next 5-10 years of the undergoing paradigm shift, the electrification of trucks is predicted to become more cost-effective and regulations are going to increase its demand for it. Thus, there is potential for FleXskrald to be a first mover in the introduction of the ongoing implementation of electric vehicles for waste management and beyond.

Sustainable Cities, Livable Cities

Urbanisation and increasing recognition of SDG goals are pushing cities around the world to rethink and respond to the increasing use of resources but in a sustainable way. Furthermore, cities including Aalborg are placing a stronger emphasis on the quality of life in cities, involving policy changes and initiatives to introduce more pedestrian streets/carfree zones thus aiming to improve its air quality whilst reducing noise pollution. Efforts to transition cities to a much livable one works in favor for the FleXskrald project where its overall impact on reducing GHG on its own may be small, but the attempt to address increasing problems with resource depletion, the continuing contribution of CO₂, increase in quality of livability in cities by tackling air and noise pollution, providing job opportunities for people outside the fringes of society etc. cannot be undermined.

Finally, the transition to sustainable cities will depends on social, cultural, economic and environmental factors. In the fast-growing cities of developing economies with increasing waste outputs, waste management needs to be met sustainably, while resources are managed effectively. In cities located in more developed economies, smart approaches are needed to ensure that cities are optimized for economic activity, energy consumption, and environmental impact

Appendix A. Interviews

The interviewees were chosen with respect to their connection to the FleXskrald project and for their experience and expertise in the field of waste management. Interviewees and their profession are illustrated in Table 10.

Interviewee	Profession and credentials as an	Date of	Type & length	
	appropriate interviewee for this	interview	of the	
	research		interview	
Charlotte	Dorte is the Director of Huset Venture of	01/03/19	Face-to-face	
Sletting	North Jutland the past two years. She has	10.00 -	interview: 1hr	
Fischer and	over a decade of experience at <i>Jobcenter</i>	11.00	See Appendix	
Dorte Sif	Aalborg as a team and project leader.		A.1	
Boddum	Charlotte is the Head of Department at <i>Huset</i>			
Kronberg from	Venture of North Jutland the past two years.			
Huset Venture	She has a background in Physiotherapy with			
Nordjylland	a background in coaching and personal			
	development.			
Overall	There are currently four flex-jobbers assigned	03/06/19	Email	
answers from	for FleXskrald project. One person is	, ,	correspondence.	
flex-jobbers	dedicated to marketing and the other three		See Appendix	
working for	persons are responsible for waste collection		A.2	
FleXskrald	and management.			
(anonymous)				
Martin	Martin Quintero Hansen oversees the Green	15/02/19	Face-to-face	
Quintero	Store for Network for Green Detail, initiatives	09.30 -	interview: 1hr	
Hansen and	from the Center for Green Transition (CGO)	10.30	See Appendix	
Nanna Shultz	at Aalborg Municipality. He is the project	and	A.3	
Andersen from	manager for the FleXskrald project with	10/05/19		
CGO, Aalborg	Nanna Shultz Andersen as a project assistant.	12:30-13:30		
Municipality	Martin has a Master's in Business Economics			
	and Financial Management at Aalborg			
	University (AAU). Nanna has a Master's in			
	Experience Design at AAU.			
Peter	Peter is the founder of <i>Rezycl.com</i> , an online	19/02/19	Face-to-face	
Hyldgaard	waste management system which is utilized	15.00 -	interview: 0.5hr	
from	for the FleXskrald project. He has a Bachelor's	15.30	See Appendix	
Rezycl.com	in International Sales and Marketing with		A.4	
	many years of industry experience in the			
	circular economy.			
Not part of the FleXskrald project partnership				
John Bernth	John has been the operation manager for	09/05/19	Face-to-face	
from HCS	HCS/Sølvkær & Pedersen for the last two	12:00-13:30	interview: 1hr	
Sølvkær &	years. He has operated and started his own			

Table 10. The interviewee credentials and information
Pedersen	company for 32 years working with cranes,		See Appendix
Brønderslev	dumpsters and heavy machinery.		A.5
Klaus Bro	Klaus has been the Project Manager and	10/05/19	Face-to-face
Bystrup from	Business Developer for Aalborg Forsyning for	14:00-15:00	interview: 1hr
Aalborg	over two years with a focus on circular		See Appendix
Forsyning	economy and waste management. He has		A.6
(Aalborg	previous experience in PR consulting with		
Renovation)	Hjørring Municipality and also under his own		
	company.		
Lisa Dreier	Lisa is the Senior Environmental Consultant	03/06/19	Face-to-face
from Marius	(for the bigger customer base) for Marius	11:30-12:30	interview: 1hr
Pedersen	Pedersen for almost four years. She has over		See Appendix
	decade of work experience in management and		A.7
	customer service with an educational		
	background in Business at AAU specializing		
	in the LEAN process (interview notes not		
	included in Appendix due to privacy reasons).		
Various shop	Various shops (n = 64 shops in total, 20	18/03/19	Face-to-face
/business	rejected the survey, and only 37 shops	to	interview
owners and	completed the survey) ranging from small to	19/03/19	See Appendix
workers in the	large sizes in the main pedestrian streets of	11:00am to	A.8
main	Nørregade, Bredegade, Algade, Bispensgade	4:30pm	
pedestrian	and Gravensgade in Aalborg city center. See		
streets of	4. Results section for more information on the		
Aalborg	outcome of the survey, Appendix A.8 on		
(anonymous)	survey questions and interview notes from		
	shop owners and B.2 for statistical data.		

Appendix A.1. Semi-structured interview notes with Huset Venture North Jutland

Interview notes from Charlotte Sletting Fischer and Dorte Sif Boddum Kronberg Head of Department and CEO for Huset Venture, Nordjylland (HVN)

Date: 10.00-11.00, Friday, 1 March 2019.

A face-to-face meeting at Bouet Møllevej 16, 9400 Nørresundby.

What are your roles at Huset Venture North Jutland?

Dorte has been the CEO of HVN for 2 years and Charlotte has been the Head of Department (for two departments). Dorte has worked for Job Center Aalborg for over a decade as a team consultant, project leader and consultant.

They recruit and help flex jobbers and give them appropriate training and support for them to work for a private company (i.e. REAL jobs for REAL people). HVN pays the flex jobbers wages (Approximately 10% more margin on the typical hourly wages for flex jobbers which are used to pay for HVN's services). The need for HVN comes in because companies like IKEA is too big to take care of flex-jobbers, so HVN steps in to help and support the flex-jobbers and checks upon them to see if they are settling in well with their new job (i.e. once a month or once a week) and manages any problems or issues.

What is a flex jobber?

Flex-jobbers are people with reduced working capacity due to their permanent disability (both mental and physical). They are hired at HVN but work for other companies (i.e. IKEA – at the canteen making food, cleaning etc.). They have a range of projects and different people, for example a former soldier with PTSD. If the disability is mental, you need papers from several doctors. It can take 5-10 years to get the right papers (for example, anxiety is hard to document). Usually, people we get at HVN are those far from working. Some people have never had a job, therefore, no experience in the job market, some may have had their kids removed from their house because of alcohol or drug issues or have grown up in an environment where their own parents also never had a job, thus never learned to have an "identity" of work. These are people who have tried everything. These people are categorized under the "red" group who usually take approx. six months to a year to get them on their feet to find a job but for more mild clients with fewer disabilities (i.e. Green group) it takes on average about 13 weeks for them to work.

What does it mean when Huset Venture is categorized under "selvejende" institution?

It means it is a non-profit orientated business, but not a charity or an NGO. Any profit made is reinvested into the company. These social economic companies have different levels of finance. HVN gets funding every year from the state which was the way they were founded due to the necessity of having enough funds to pay wages. Funding is important to work on projects such as the veteran project. However, HVN aims to be independent due to the uncertain guarantee of the funding from the government in the future. Every year, HVN has to spend the funds given by the government otherwise they will get less funding the following year.

Currently, how many flex-jobbers (approx.) are registered with Huset Venture at North Jutland branch? And how many of them have flex-jobs?

There are 40 employees at the North Jutland branch and currently, they have 35 flex-jobbers. About a third or a quarter of the flex jobbers are in the green group and red group respectively. The recent turn in Danish politics is pushing HVN to get the red groups into the green group. This has become HVN's biggest goal.

What is the average time of work hours per week for a typical flex jobber? 10-12 hours a week (4-5 hours minimum), most of the flex jobbers are at 20hrs per week.

Is there a specific definition (criteria) for the term "meaningful" job, provided by Huset Venture? Not really. However, there is a reason why in Denmark there is a high employment rate. Working or having a job is embedded in the Danish cultural identity. You can say work is a big part of one's identity. Therefore, you can be judged on the basis that you do not have one. This is a social taboo. Sometimes people lie about their jobs if you don't have a job. Even the government is really pushing to get people out of the lower bracket of unemployment benefit called *kontanthjælpe* (which you get after 2 years of *dagpenge*, the higher unemployment benefit).

If not, what is your definition of a meaningful job?

Real jobs for real people. This is a response from fictitious mock projects where people with disabilities would go on to work for companies that were fictional as part of mock trials. This may work with people with very low cognitive abilities but not others who can find it demoralizing. Therefore, it is important to make it real to instil a sense of pride, responsibility and acknowledgement. HVN has real customers buying their service, where they have to show professionalism and good work which is important for people with disabilities.

How important is fulfilling Corporate Social Responsibility (CSR) for Danish companies, especially in North Jutland?

CSR is growing fast here. Nobody wants to be left behind. Therefore, utilizing FleXskrald project or HVN would be the easiest way to achieve CSR for companies. Companies can have CSR without any effort. For 10%, you pay more for the flex-jobbers wages, it still comes out cheaper than hiring a regular full-time employee because you don't have to pay for holidays, sick leaves, etc. Also, they are guaranteed that the jobs are done by sending another flex-jobber to complete the job (but only applicable for simple jobs). Sick leaves are compensated by the government, not the employer.

What are your roles at the FleXskrald project?

Martin Hansen asked HVN to join the project. HVN is part of the creation team focusing on targeting the triple bottom line, financial, social, environmental. Currently, four flex-jobbers are employed three to collect waste, and one person dedicated to marketing and selling the services and raising awareness. There are in house flex-jobbers (graphic designers) at HVN that make all the promotional materials such as the logo, poster, website, social media, etc. Some of the environmental operations that HVN has undertaken is eliminating plastic bottles to using only environmentally friendly cleaning products for the cleaning jobs. HVN mainly focuses on the two-bottom line – social and economic. Currently, the price for going to the recycling station (genbrugsplads) is currently 200kr per visit if you are a business (as an individual the disposal is free – Many businesses go as individuals, but this is illegal). Therefore, FleXskrald charges the same market price. The benefit of FleXskrald is that it is dedicated to easy solutions by making it convenient. This is the key selling point for FleXskrald, that it is easy and cheap.

Why were bicycles not considered for FleXskrald project?

Due to the large size requirements of the trash and the weight. Hence why it had to be vehicles. And maybe due to disabilities as well. There are currently three flex-jobbers hired for this project. Carsten will oversee coordinating, daily rounds. Lifting big weights. etc.

What do you foresee as the biggest hurdle to overcome for the FleXskrald project in relations to the use of flex-jobbers?

If the stores do not want the service and do not want to pay and do not care. However, HVN is trying to target the SDG which is a new framework that is gaining traction. For example, if you do not as a business operator comply or make an effort with SDG, then you are off the track. More customers will demand it. It is also trying to do something good for the city, with social, environmental impacts. Alloorg hosts the Sustainable festival which is unique for Denmark. It is part of the city's wish to be greener. So, FleXskrald is starting on the right track in the right place. The presence of the University also helps to transition to a greener city and makes this city special.

What are the biggest barriers that Huset Venture face?

Funding. See the answer above. Also, not many people are aware of the services that HVN provides. It could be helpful to others who may be in need but do not know how to access these resources.

What is the main goal for Huset Venture in the FleXskrald project?

To bring flex-jobbers up from dependence to independence as highlighted in the HVN's eligibility hierarchy (see Table 9).

Appendix A.2. Semi-structured interview notes with flex-jobbers from Huset Venture North Jutland

Interview notes from Charlotte Sletting Fischer and Flex-jobbers for FleXskrald

Date: Monday, 3 June 2019.

Email correspondence.

- How do you define a "meaningful" job VS a good job? Is there a difference? Answers from flex-jobbers: A good job is just a safe job with good pay. A meaningful job is a job where it is also fun to go to work and where there is a need for me. Where it makes a difference whether I contribute or make an impact or not.
- 2) Is it important to you that you are given the opportunity and support to be able to work? How important is it for you to have the opportunity and support to work? (regardless of how many hours and especially for those with physical and psychological conditions that makes it hard to work)

Answers from flex-jobbers: VERY IMPORTANT. ⁶¹It means everything for me to have a job. I get happier, have better finances and be much more content. In my life, that means everything.

⁶¹ Based on Likert scale ranging from: Very important, Important, Moderately important, Slightly important to Not important (see Methodology).

- 3) Would you consider collecting recyclable waste (such as plastic, cardboard and paper) to be recycled into a meaningful job or a good job? Answers from flex-jobbers: YES. I do something good for the environment and it is really important that we all take responsibility.
- 4) Do you think the public and private sector should exercise more efforts to tackle the impact of climate change? (i.e. CO 2 level rise, more extreme weather, sea level rise etc.) Answers from flex-jobbers: STRONGLY AGREE.⁶² I believe that all private companies (i.e. private waste collection companies), as well as businesses (i.e. shop owners), should do something to ensure a good environment, that is everyone's responsibility as a society.
- 5) Has working for FleXskrald been different or similar from the previous jobs you have had in the past?
 Answers from flex-jobbers: YES. It's great to work with fleXskrald, it is flexible, fun, and

also, we get to do something good for the environment, it makes really good sense to go to work.

6) What do you personally hope for the end result of FleXskrald project? Answers from flex-jobbers: I hope, of course, it will be permanent.

Appendix A.3 Semi-structured interview notes with Aalborg Municipality

Interview notes from Martin Quintero Hansen and Nanna Schultz Andersen

Project Manager and Assistant for CGO, Aalborg Kommune Date: 09.30-10.30, Friday, 15 February 2019 and 12.30-13.30, Friday, 10 May 2019. A face-to-face meeting at Stigsborg Brygge 5, Nørresundby.

Information on the operation of FleXskrald project and its progress

- FleXskrald was a conception from Martin Quintero Hansen is the project leader from Network of Green Detail from Aalborg Municipality. The idea of FleXskrald came about whilst realizing the need to address the problem of commercial recyclable waste to be collected in a more environmentally friendly manner whilst utilizing the available central waste collection space provided by the main shopping mall and supermarket in Aalborg (i.e. provided by *Føtex* and *Salling*).
- For FleXskrald, the pedestrian street in the city center in Aalborg is the main focus. However, it could be utilized in other parts of Aalborg or in other small cities such as Viborg, Nibe, Vodskov, etc. Currently, there is no data on how they manage their commercial waste. Vodskov might be easier to collect data and to work with as the Aalborg Municipality has

 $^{^{62}}$ Based on Likert scale ranging from: Strongly agree, Agree, Undecided, Disagree, to Strongly disagree (see Methodology).

established a relationship with 20 shops. It is important for the Aalborg Municipality to strengthen the connection and relationship with them.

- Martin and Nanna conducted an initial market survey of 40 shops in the pedestrian streets. Most of them have a waste collection agreement with a private company mainly being Marius Pedersen. These shops the municipality is NOT allowed to target as to not take customers from the private waste collection industry.
- 15 shops are not interested about FleXskrald project, 13 are interested in hearing more about FleXskrald model, 27 have private agreements. Martin & Nanna predict that 80% of the shops in Aalborg have an agreement with Marius Pedersen to collect their recyclable waste.
- It is the small shops that are of FleXskrald's target market as many have an improper practice of discarding their waste where some shops may discard their waste in the recycling station (genbrugsplads) as a resident rather than as a business.
- If the private waste collection companies like Marius Pedersen adopted the FleXskrald model, the CO₂ savings would be the greatest from replacing their diesel trucks. Also, there may be potential for Flex-jobbers to be employed under Marius Pedersen as well. They have their own recycling sorting center in Aalborg East. Aalborg Municipality is more network-based and has an interest in also establishing networks and collaborate with the private waste collection industry.
- Rezycl may be able to calculate the CO₂ emissions based on kgs of waste collected.
- Mainly for the shops, they are motivated by economic factors as their priority, followed by convenience and then CSR. Therefore, it is important that FleXskrald match the market price and emphasize time saved from going to the recycling stations (genbrugsplads).
- The electric moped *Tripl* is designed by a Danish company and the electric van is Nissan E-NV200 from 2015 both with a lithium battery.
- Through FleXskrald it could boost confidence for the workers. No one has tried this, so there will be trial and error. There is no framework. There is potential for this job to be meaningful for these people who are outside the job market.
- The total budget for FleXskrald is 4,619,700 DKK (Danish Kroner) where half of the budget is funded by the EU and the rest co-funded by the partners (i.e. by monetary means or/and through donated labor and time)
- Marketing material / next step / going to stores and do you want to sign up.
- FleXskrald is subscription based. Different from Marius Pedersen or other private companies where they charge by weight.
- FleXskrald operates during and outside business hours. Service vehicles are allowed access to the pedestrian street during the hours of 5 am to 11 am.
- FleXskrald had 5 customers as of the first month, and 12 shops in the second month. Bearing in mind that they are on the free three-month trial period. It would be interesting to see if these customers remain and pay for the services after the 3 months trial period.
- There is a grey area where if the shops are mixed in with the residents under the same

landlord, they probably can use the black bins esp. if the amount is small. But they would get filled up rather quickly because I believe the municipality (Aalborg Kommune) only collects this x1 per month for pap and plastic.

- FleXskrald is also interested to see how it will continue after the three-year trial period. The aim is to get the private industry to adopt this system of electrification, central collection and utilizing flex-jobbers. It would also be interesting to see this model applied in smaller cities like Vodskov.
- Currently, there is a komprimator (waste compactor and storage) in the back-of-house of the two shops called Salling and in Føtex in Aalborg city center, which is also used by them as well, so FleXskrald waste gets mixed in with them. (hence it is important that FleXskrald waste gets weighed to let Føtex and Salling know). Thus, there are two destinations for the EVs to drive to. Stena comes to pick up the garbage from Føtex and Salling (which is done by a diesel truck). FleXskrald, therefore, is just tapping into an existing loop that is already established. However, it will take longer for trucks to make their way around the pedestrian streets, but the moped and electric van will have a way easier time and be quicker and quieter.
- At the moment there is an x1 moped, x1 van and x4 flex-jobbers doing not just the garbage collection but also promo and marketing. Therefore, there are no established routes yet as it is still early on in the game.
- There is also an EV and electric moped charging station next to Salling where the EV and the moped are also parked. So, they don't need to be dropped off in another location outside the city saving more energy. Also, the workers live in the city center too.
- The customers that have signed up for FleXskrald are already suggesting and finding out that they have other waste fraction that is currently not recycled such as the expanded polystyrene (called Flamingo, EPS). It is currently going to incineration. FleXskrald is figuring out potential ways in which other materials like this can be recycled. (i.e. bottles that are rejected in the pant system), organic waste collection from restaurants, etc. After July, Himmerland will collect these expanded polystyrenes from the shops and press the air out of the polystyrene and deliver it to a recycling plant in Hanstholm near Thy that recycles these packaging materials.
- The social impact of FleXskrald would be that these flex-jobbers will not be relying on government support as much which has economic savings. Also, these flex-jobbers will be paying tax from their wages. <u>http://densocialeberegner.dk/</u> is an online calculator that will indicate how much tax they contribute (taking into consideration their government support). Also, the impact comes from these flex-jobbers moving up the ladder of need (refer to Huset Venture interview) where they become more and more independent. This job may lead to further future jobs for these flex-jobbers as well.
- Currently, Rezyl is collecting the data on their online app. They are collecting the shop, the distance, weight, etc.

Appendix A.4. Semi-structured interview notes with Rezycl.com

Interview notes from Peter Hyldgaard

Online waste management consultant, Rezycl.com Date: 15.00-15.30, Tuesday, 19 February 2019. A face-to-face meeting at Stigsborg Brygge 5, Nørresundby.

- The need for Rezycl.com came about because the Aalborg Municipality collects municipal waste (restaffald) but do not measure it. There is huge power in information and documenting it in a way that could be useful to waste generators and companies.
- Aalborg is the only municipality in Denmark where it holds the right to collect municipal waste from businesses/commercial waste. Other municipalities, private waste collection companies also collect municipal (restaffald) waste from businesses/commercial.
- These private waste collectors offer waste solutions, based on their current logistics. So, if there is a private waste generating company which has a specific requirement that differs from the usual service of the private waste collection company and can't meet the specific requirement and they won't do it. So Rezycl is an online tool, that can help the waste generating company's match with a provider who can offer those specific services to ensure that the waste generating company can make the right decision. For example, if a company sends out a tender through the Rezycl app, looking for a third-party secure shredding service, this is possible since Rezycl includes all the players in the market. Whereas the private market only caters to their own service which can sometimes be inflexible. This is where Rezycl comes in.
- The Rezycl web app is the tool. It allows the company to set up the info cards of the bins (i.e. X bin holds X amount of waste, is stored in this area... etc.). Every waste generating company can use this app to order collection at an agreed price.
- Data collected on Rezycl are, how much waste (in tons), when to collect, the price for collection etc. It can be used to assess the current mode of waste disposal for a company and calculate savings based on any behavioral changes.
- Private companies have their own internal system for ordering and collection.
- Rezycl is looking for funding to upgrade the current version to be able to do payment transactions as well and include more information and functions for the user. The software they have now is currently a basic system but is looking to be developed further.

Appendix A.5. Semi-structured interview notes for HCS

Interview notes from John Bernth

Operation Manager for HCS Brønderslev (former Sølvkær og Pedersen) Date: 12.00-13.30, Thursday, 09 May 2019. Face-to-face meeting at Ahornvej 8, Brønderslev

- HCS services everywhere between Skagen to Hobro including Aalborg and Brønderslev.
- There are 2-3 drivers for Aalborg, serving approximately 200 businesses all over Aalborg (not just in the city centre). One of the customers is Elgiganten in the city centre. He cannot say how many customers they have in the pedestrian streets.
- Once a week is the most common form of waste collection schedule. HCS provides flexible pickup services catered to each customer. Approximately, HCS goes to Aalborg city on average 2-3 times a week. The trucks are allowed access on the pedestrian streets between 5 am to 10 am.
- The 770L bin has about 20kg of cardboard which is put into a baler and squashed to go in the collection trucks.
- Cardboard is usually inside the bins or in bundles, but plastic is usually in a big clear plastic bag (usually packaging plastic films only). They usually weigh 6kg per really big bag (see Figure 16 below)



Figure 16. Plastic bags full of plastic films for collection (photo taken by the author on 09-05-19)

- The drivers have an iPad in which they record the weight of the waste from the truck after each round and records it in the system. These data are shared with customers who need their waste info to get ISO accreditation. HCS also needs to provide this data to the Ministry of Energy.
- The recyclable waste materials that are collected from Aalborg goes to Stena in Nørresundby and Ragn-sells (<u>https://www.ragnsells.dk/</u>) for it to be processed and sold/sent to another recycling factories. HCS have their own recycling center but it is in Glostrup in Zealand, where they pre-treat and sort the waste. There are several recycling factories in Jutland

where recyclable waste material is reprocessed into raw material. There is one in Hadsund for plastic and one in Aabenraa (that goes to Germany) and another called Aage Vestergaard Larsen Reuse (<u>https://avl.dk/</u>).

- The trucks are of various sizes but usually are 10ton trucks able to carry municipal waste for incineration, and some models with a compartment for cardboard and plastic.
- The trucks go back to Brønderslev after their collection schedule. However, John has heard that in other companies, the drivers can take their trucks home, so they don't have to come to the office to drive them again. The trucks are all diesel and use approx. 4km/litre.
- HCS has Komprimators placed around Aalborg city (there are one placed in Aldi and Føtex). Which can store large quantities of waste and compresses them (i.e. cardboard). The komprimators can be driven to Stena. But this is a bit more expensive than trucks because you need cranes (more expensive equipment) to drive these.
- The waste industry is good for these flex-jobbers because the work here is very flexible. i.e. garbage collection, truck and bin washing etc. They need more young people to work in this industry. HCS has also had to disable people as part of their labor force since the waste industry provides jobs that are perfect for flex-jobbers that can only require a few hours a day.
- He believes recycling more waste is a good idea, however, the problem right now is that there is too much plastic that is produced and not enough people buying them. There are also complications in soiled plastic that is dirty or colored plastic as they are difficult to recycle (if the plastic is dirty, they end up getting incinerated). Therefore, we should not try to destroy the incineration industry which is good for using these waste materials that is difficult for it to be recycled into useful energy. Sadly, the EU is trying to destroy the incineration industry despite the fact that garbage burning is better than burning coal.
- He believes FleXskrald may not be the most efficient system as the rubbish trucks handle more waste and will all be replaced by electric in 10-15 years anyway. In the future, relying on fossil fuels will not be economical nor competitive. John suggests that the Aalborg Municipality could be supporting the private market by recommending them to the shop owners to help increase recycling.
- The bins 770L are 7kr a month to hire. For plastic, paper/cardboard the payment is per collection (not by weight), which is 35kr to 50kr per collection. Whereas waste for incineration (småt brændbart) you need to pay per weight which is 600kr/ton, which is like 6kr per kilo.
- The main reason why the customers leave HCS is they could not be satisfied with their services or for cost reasons. John thinks these customers are not considering the time and money that you need to spend to drive to the recycling stations (genbrugsplads), not realising that it is more expensive to do drive themselves which is time spent that is not taken into the calculation. John also thinks that utilizing valuable square meters of shop space for storing cardboard or plastic waste is also an extra expenditure not considered and

unnecessary. John believes that shop owners may not know about the alternative affordable and easy services that HCS provide or may not want to know about it.

- John thinks that the public waste collection system perhaps is not the most flexible or efficient. HCS provides similar services to other private competing companies.
- HCS currently collect organic waste from traders, such as from merchants and restaurants. It is a new initiative that they are expecting a lot from. So far, there are probably approx. 5-6 customers in the Aalborg area.

Appendix A.6. Semi-structured interview notes for Aalborg Forsyning

Interview notes from Klaus Bro Bystrup

Project Manager for Aalborg ForsyningDate: 14.00-15.00, Friday, 10 May 2019.A face-to-face meeting at Over Bækken 2, Aalborg

- It is important to understand the political and legislative history of this industry in Denmark. Before 2011 in Denmark, the municipalities took care of collecting waste from the residential and commercial sector. However, the Liberal government wanted to take care of the private market which enabled a law that allowed the private waste collectors to collect recyclable waste such as cardboard, paper and plastic only. This meant that the Municipalities could only collect normal garbage (restaffald) from households and businesses, and recyclable waste only from households. FleXskrald is in a dodgy situation because legally speaking, it is not allowed to operate as a recyclable waste collector under the municipality and it also requires certification to collect private business waste.
- Technically speaking, the businesses/shops are not allowed to use the bins that are provided for the residents. This is the law. The shops/businesses need to use private waste collectors. However, we as the municipality do not go after people and penalize them for using these residential bins, especially if they are of small fractions and is part of their landlord's contract. The majority of the waste is produced by the residents living above these shops anyways.
- A better system would be to utilize the delivery trucks that drop-off goods to these stores. Why don't they take the cardboard back with them instead? The trucks are already there, so you could really utilize this pre-existing infrastructure.
- The false narrative is that incineration is just only bad. Currently, the government is making it expensive to burn waste imported from the UK. However, if they are not recycled, at least they should be burned.
- There is no data from 2006 from the private sector as these data is held with private companies due to the changeover from collecting commercial waste from the

municipality to the private industry.

- It used to be that the private market had a conflict of interest where environmental issues were not their main objective. But the narratives are changing, and through CSR, now these companies are more responsible.
- The Aalborg Municipality is planning a 5-year period (with awareness campaigns for the residents) where they will be introducing new bins for the inner cities that will be buried under the ground. This will get rid of all the black bins that are stored in the back yards of residents. This also means that the residents and shop owners would need to walk longer distances to dispose of their garbage (but not more than 75m as the tolerated walking distance). They also plan to have sensors on them, so they only need to be emptied when it is full, but this requires data to be gathered for a period in order to really streamline this smarter way of waste collection. Currently, they are in year 1 of this phase. This would have an impact on the FleXskrald project.
- It is important that the solutions we come up with for the future involves all the stakeholders in this industry and work collaboratively towards a better solution that would lead to more recycling and reusing (and reducing) of waste materials. It has to have a good business case in order for it to work.
- Currently, the contaminated waste fraction is an issue. This is usually due to ignorance and laziness from the households; however, it is also important that better products are manufactured which makes it harder for contaminated fractions to occur.
- The past 30 years, EU has been dependent on China and Asia as loopholes for recyclable waste in the past lead to the whole plastic industry to be complacent with using unrecyclable plastics, or plastics that make it difficult to recycle.
- Other European countries are better at sorting and recycling waste than Denmark. Denmark is just starting, thus the production capacity for recyclable waste is not there yet.
- Reno Nord where most of the waste is sorted and pretreated is run by four municipalities. Reno-Nord has the incineration facility. Every municipality is trying to reduce the number of plastics being burned. Ragn-sell makes the recycled waste ready to sell for the recycling market in the EU. For a specific type of plastic such as plastic garden, chairs are exclusively taken to M.Larsen (<u>http://www.mlarsen.dk/</u>) or AVL, another recycling company that recycles them.
- A lot of the plastic that is being recycled at the moment is from the industry where you can expect a consistent grade of plastic that is not contaminated. Public waste is not reliable for consistency and is often soiled or not sorted properly. The past 2-3 years there have been efforts to recycle plastic. So, you have to bear in mind that it is still in the early stages.
- The recycling stations/Genbrugsplads you pay per visit. For example, for a trailer, it is 200kr per visit.

- In the future, it would be useful to turn these plastic wastes into oil/fuel to supplement its use.
- Aalborg Forsyning also uses people who are disabled or have usually been on unemployment benefit (*kontanthjælp*) from the government. They are the ones putting branding stickers on the bins (yellow hearts). It means a lot to them that they are part of a larger system that has an impact on every citizen as everyone has a bin and need to empty their waste. They feel connected to society and derive meaning from what they do because they feel like it has an impact.
- FleXskrald is not a circular solution as it does not delve into the waste chain/cycle. It needs to embrace LEAN principles. It needs to consider everything from product chains to consumers. (i.e. clothing factories that take all the packaging back with them after delivering the goods to the stores. Thus, the clothing manufacturers/delivery services need to be part of the circular economy/recycling process). IKEA is starting to do this. FleXskrald need not be a "postpone" strategy by focusing only on recycling but focus on actually changing the broken system in itself.
- For waste from households are collected by the Municipality. The Municipality can by procurement choose private companies to be the operator. In the city-center, it is the Municipality itself (Aalborg Forsyning) are the operator.

Appendix A.7. Semi-structured interview notes for Marius Pedersen

Interview notes from Lisa Dreier

Environmental Consultant for Marius Pedersen Date: 11.30-12.30, Monday, 11 April 2019. A face-to-face meeting at Korinthvej 103, Aalborg East

Note: Majority of the interview content has been omitted due to request from Lisa Dreier.

• The weight of paper or plastic film differs a lot. It is dependent on how well the paper, cardboard or plastic are compressed in the container. E.g. If you cut the cardboard in small pieces your container can contain more than if you put a whole cardboard box unfolded in the container. On average Lisa states: 660L container emptied once a week holds 50kg cardboard or paper and 20kg plastic film.

Appendix A.8. Survey and semi-structured interview notes for the inner-city shops of Aalborg

1-2-minute survey to understand the current recyclable waste (paper, cardboard and plastic) disposal behavior of the shop/business owners in the main pedestrian streets of Aalborg

N = 64 shops/businesses from the main pedestrian streets of Aalborg (Nørregade, Bredegade, Algade, Bispensgade and Gravensgade)
Date: 11.00-16.30, Monday, 18 March and 11.00-16.30, Tuesday, 19 March 2019.
A face-to-face survey and follow-up quick interview

1)How does this shop dispose paper/cardboard waste? (Please circle and state) Through a private waste collection company – Please state company: a. The shop owner disposes it themselves – Please state how: _____ b. Other – Please state how: c. 2)*How does this shop dispose plastic waste?* (Please circle and state) Through a private waste collection company – Please state company: a. The shop owner disposes it themselves – Please state how:_____ b. Other – Please state how:_____ c. How often does the paper/cardboard waste gets collected? (Please circle) 3)a. Every day b. Couple of times a week Once a week c. d. Once every two weeks e. Once a month f. Other: Please state: _____ 4)How often does the plastic waste gets collected? (Please circle)

- a. Every day
- b. Couple of times a week
- c. Once a week
- d. Once every two weeks
- e. Once a month
- f. Other: Please state: _____

5) What is the average volume $(m^3 \text{ or } L)$ and number of the paper/cardboard waste bin(s) per collection/disposal? (Please state and circle)

- a. Average volume of a bin: _____m³/Litre
- b. Average number of bin(s): ______per disposal
- c. Average % of paper/cardboard in bin(s) (please circle):
 - 25% full, 50% full, 75% full, 100% full

- 6) What is the average volume $(m^3 \text{ or } L)$ and number of the plastic waste bin(s) per collection/disposal? (Please state and circle)
 - d. Average volume of a bin: _____m³/Litre
 - e. Average number of bin(s): ______per disposal
 - f. Average % of paper/cardboard in bin(s) (please circle):
 25% full, 50% full, 75% full, 100% full

5-minute questionnaire to understand and find the best ways to help the current plastic and paper waste disposal in the pedestrian street shops

- 1) What do you find is the most inconvenient and problematic with the current way of disposing of paper/cardboard and plastic waste?
- 2) What are your suggestions on improving the current method of collection and disposal of paper/cardboard and plastic waste?
- 3) Is the current price of waste collection affordable? (please circle or state) Cheap Affordable Expensive Other_____
- 4) What do you think about utilizing another way of collecting paper/cardboard and plastic waste via electric moped to reduce air pollution, noise and reduce fossil fuel use by replacing diesel trucks?
- 5) What do you think about employing people with reduced working capacity (such as people with disabilities) as laborers who collect paper/cardboard and plastic waste?

Some of the key overall responses from the shops:

- Insights from a small-sized jewelry shop owner: Aalborg Municipality's plastic bin is combined with metal which makes it hard to state how much plastic this shop produces. Also, plastic waste is not always recycled and gets mixed in with municipal waste (restaffald) due to the owner's "laziness." Most of the waste produced in this shop is very small and is usually food waste from lunch consumption. The shops that are leased comes with their own arrangement for waste disposal set up by the landlord, therefore some shops have a good arrangement, and some do not. Businesses usually have better bin systems than the residents living above.
- **Insights from medium-sized beauty shop workers:** The plastic waste is usually from the packaging of the goods from the shop. The plastic and municipal waste are shared between the shop and the residents living above.
- Insights from medium-sized glasses shop workers: They did not have a bin for cardboard but cardboard storage outside, which was just a simple shed where they flattened cardboard and stacked them to be left outside for collection once a week.



Figure 17. Cardboard is left outside in bundles or inside one of the cardboard boxes for shops that do not have bins

- Insights from a large sized clothing shop worker: The cardboard boxes are reused where possible. The plastic packaging is sorted into clear and colored films which they get paid for recycling them by a private company. The plastic bags are also reused where possible. The company is looking into changing their plastic bags to paper bags.
- Insights from a large-sized bookshop owner: They separate paper packaging and cardboard. They have a big storage room for waste, so they do not have to pay a lot of money for private waste collection because they don't need to be collected often.
- Insights from a small-sized mobile phone service shop worker: They use the Aalborg Municipality bins across the street because for some unknown reason they cannot access their own back storage which is always locked. Therefore, they have no space for bins. However, they create little cardboard and plastic waste for it to be a real problem.
- Insights from a small-sized jewelry shop owner: Three floors of residents that live above the shop use the same x1 municipal waste bin (restaffald). No paper or plastic is sorted. The owner reuses cardboard packaging where she can, or sometimes collects them and dumps them to the recycling stations (genbrugsplads), but everyday little plastic packaging she gets for her shop goes into the municipal bin (restaffald). She wonders why the business has no separate bins from the Aalborg municipal bins and why it is shared with residents. She also produces organic waste in the shop from lunch. For her, it doesn't make financial sense to pay for private waste collection as it is expensive to order a collection every week for a shop her size that produce very little waste. The shop is very small so there is also very little space at the back for bins, therefore she wishes there were more underground street bins for these small businesses installed by the Aalborg municipality.
- Insights from a small-sized mobile repair service shop worker: They are currently,

not recycling paper nor plastic, but they are interested in an eco-friendly recycling system. However, they have limited space available for bins. They do not mind spending the time to sort different types of recyclable waste. Their Aarhus branch already recycles their cardboard and plastic waste.

- Insights from a small-sized shoe store owner: When new stock arrives, there is a lot of paper and cardboard, so the waste varies between season and stock. They have heard about the FleXskrald project, but it is unaffordable for them. Money is the biggest issue for them using a private waste collection service.
- Insights from a large-sized café worker: Very little plastic is produced as they use ceramic cups inside and plastic cutlery or cups are taken away by the customers. Mainly, they produce food and packaging waste. They also use *Too Good to Go* app which sells leftover food very cheap to minimize food waste.
- Insights from a large-sized mobile service shop worker: They produce a lot of plastic packaging waste. Approx. 2 big bags of plastic packaging per week. They admitted that it was a bad practice that they didn't recycle plastic waste and that they should. The worker assumed that cost and time was some of the reason why the shop has not been recycling plastic.
- Insights from a large-sized café worker: There is not much plastic waste but a lot more food waste. However, there is not enough space in the bins at the back for cardboard and their municipal waste (restaffald) is shared with the residents and is always full. So, they usually leave excess waste in plastic bags next to the bin. Plastic is not sorted as there is not much waste produced and the café is so busy there is no time to sort them.
- Insights from large-sized clothing shop worker: They don't have bins just the municipal waste bin (restaffald). Therefore, their cardboard waste is flattened with the plastic packaging that goes into big plastic bags and left outside for Marius Pedersen to collect. They sometimes order a private collection of special waste such as metal and pay for it. Their waste production varies a lot, for example, this week was stock up day, so they had a lot of paper and plastic waste.
- Insights from large-sized café waste manager: In June this year, the franchise as a whole are looking into implementing plastic recycling bins as this is already happening in the Copenhagen branches. They would also look into glass recycling. They would like the waste collection service for it to be sorted by the company and not use their own labor. They find the current waste collection service very expensive. Fee for one bin is 4700kr to purchase with a 475kr delivery fee of the bin, and costs 1242kr for one collection per week for two 660L containers. It is important that they use the same company throughout all the stores in Denmark for waste collection for consistency and to receive discounted rates. They would prefer bins to be underground as the birds are getting to them when they are full. They suggested the IKEA model where IKEA gets paid to sort and recycle their waste and

that recyclable waste is collected by another company.

- Insights from a medium-sized clothing store owner: They expressed that they had no issue with their current way of waste disposal (they do not recycle plastic and leaves their cardboard outside for private collection). They stated that they do not care about whether their waste was recycled or not. They had no intention to change and think the cardboard collection service is affordable.
- Insights from a small-sized candy store owner: For the owner's small candy shop the waste it produces is so small that it is taken with the owner to be incorporated into her residential waste for both paper and plastic.
- Insights from large-sized bookstore owner: Normally there is not much plastic waste produced other than clear wrapping for books. They currently do not recycle plastic but would be more inclined to recycle if there was a plastic bin provided for them by the Aalborg Municipality.
- Insights from a medium-sized clothing store owner: During Christmas period they get cardboard collected more frequently due to more stock arrival (i.e. twice per week). They think that the current system of private waste collection is affordable and a reliable system. No intention to change.
- Insights from a medium-sized food/drinks shop owner: The owner was adamant that the shops around her were recycling everything properly as this is the Danish way and is a cultural norm to do so. She takes her glass bottles by driving to the recycling station (genbrugsplads) which is about 5min drive. The bins from Aalborg Municipality are shared with the residence and this is in the rental agreement. Her waste stays within the limit set by the municipality, so she believes there is no need to pay for a private waste collection company. She thinks the organic waste produced by restaurants and cafes are more of a problem in the city
- Insight from a small-sized shop optometrist shop owner: The municipal waste (restaffald) bin is shared between 6-7 apartments above. This store does not recycle. She thinks sorting waste is time-consuming and annoying to do. She thinks paying even 100kr per week for collection is expensive for small shops like this one.
- Insights from a small-sized shoe shop owner: There is an only x1 municipal waste bin for everyone (residents and shops). Therefore, he only puts in small amounts of waste in the bin. He used to drive to Reno Nord to incinerate cardboard and plastic waste, where the system would weigh the car before and after and pay for it in kilos. He thinks it was approximately 30kr for 20kgs of waste to be burned, 40kr for 50kg etc. He also used to drive to Nørresundby and get paid for recycling waste, but it was such an insignificant amount that he stopped doing it. He said these shops pay 900kr for tax a year which does not cover waste disposal. He really felt it was unfair to charge that amount for small shops like his, and then he has to pay on top more money for waste disposal. Bins and storage space for

waste takes valuable retail space and in the inner-city shops, space means money. He is annoyed by the current system and finds it confusing and unnecessarily complicated. To dispose of his waste as a business requires registering at the local recycling station (genbrugsplads) which he finds at his old age complicated. Why can't it be something simple like a sticker on the car? He thinks that a new system needs to be cheap and easy. The current commercial waste collection systems were never built for small shop owners. So now, he only goes to Genbrugsplads/Reno Nord twice a year to get his cardboard burned and pays 120-150kr a year.

- Insight from a small-sized medical equipment service store owner: The plastic and municipal (restaffald) bins are shared with the entire building that includes residents. It seems like the residential sorting back at his house in the suburbia is better than the business district with fewer bins available. Therefore, he would like more recyclable waste sorting possibility with more availability of bins. Willing to pay more for recycling waste. He thinks the FleXskrald concept is a good idea, a "win-win" situation for the environment with a social cause.
- Insight from a small-sized beauty shop worker: They do not recycle because being a nail shop they get many one-off small plastics. They don't have the time to sort. They would also need several different plastic bins next to the nail station which they do not have space for. So, they go into the municipal bin (restaffald) which is shared with residents. They would like a plastic bin from the Aalborg Municipality. They pay 200kr a month for Marius Pedersen (private collector) who is flexible with a collection time. They think the FleXskrald mode of collection via electric moped is a good idea.
- Insight from medium-sized café workers: They are usually very busy which makes it hard for them to have time to sort waste (especially plastic). There is also not enough space for new bins. The owner may be interested in FleXskrald project but is dependent on the financial revenue of the café. They already have flex-jobbers who is a chef. When one of the workers worked in bars in Jomfru Ane Gade, the cardboard collection by Aalborg Municipality was free but if it was not sorted properly a fine was given of 1100kr. Maybe this is a good idea to prevent people from not contaminating recyclable waste fractions.
- Insights from medium-sized stereo shop owner: They reuse some of the old plastic packagings for packaging when sending off goods. But they produce not so much plastic. They are willing to pay for plastic disposal and is interested in the idea of FleXskrald scheme. There is not enough space for a plastic bin at the back. They currently pay 500-600kr a month for a private waste collection (i.e. Marius Pedersen). Price is a really important factor.
- Insights from medium-sized lifestyle shop owner: They have a wagon where they load the car with cardboard and drive to the local recycling station. They are interested in a new waste collection system like FleXskrald), but in the end, it all comes down to

affordability for a small shop like theirs. They have tried to reduce packaging by asking the manufacturers where they get their goods to use less packaging.

Appendix B. Supplementary research data

Appendix B.1. Introduction to FleXskrald

Stakeholders of FleXskrald

There are four main stakeholders involved in the FleXskrald project (co-funded through monetary means and donated time). The planning and execution of the project are driven by these four different stakeholders, each with varying roles and involvement.



Figure 18. Logos for the FleXskrald project and the project partners

Major stakeholders

- 1. Project Facilitator: Aalborg Kommune, Center for Green Transition (Green Shops)
- 2. Data collection: Aalborg University, Department of Planning
- 3. Labour: Huset Venture (Huset Venture), Nørresunby branch, North Jutland

4. App (Data collection and operation): Rezycl.com, Brønderslev, North Jutland

Rezycl.com has developed an online waste management system for companies which has both economic and environmental benefits. It is designed as a one-stop tool for easy ordering of bin collection, that gives a total overview of documentation and focuses on optimization. For example, the system allows the waste generating companies to set up an "info card" of their waste bins (i.e. X bin holds X kgs of waste, stored in X area etc.), which the Rezycl.com platform can allow waste collecting companies and waste generating companies to bid for an agreed price for collection and disposal. It will also collect data to analyze waste quantities and compile statistics on its waste, to assess if there are any cost and time savings. This easy overview of finance, inventory and sales are what makes the FleXskrald project "smart" through the utilization of technology (NBE, n.d.). Currently, Rezycl has not yet enabled to have payments to be part of the transaction, therefore, Rezycl is looking for funding to provide a payment system to be integrated with the app.

At a time when greater demands are made on companies' documentation of sustainability, Rezycl can issue documentation of the company's sustainable business practice through the Rezycl Verified status. It is part of the Network of Sustainable Business Development in Aalborg. It wants to boost the circular economic principles by developing a new version of their system called "circular symbiosis platform" by linking companies that could have an interest in utilizing the waste material as an attractive resource rather than to be discarded for recycling (NBE, n.d.).

For FleXskrald, the waste will be weighed, and an overview and documentation of waste types will be ensured correct disposal and recycling. This will be all facilitated by the web app Rezycl.com for the smart data collection on the waste as shown in Figure 19. Rezycl is the innovative component of FleXskrald project, which allows easy tracking and collection of data that enables knowledge about one's own creation of waste.



Figure 19. How the web app Rezycl.com works drawn by the author (NBE, n.d.)

Minor stakeholders:

<u>Central waste collection and compaction point</u>: Salling Group A/S Department Store and Føtex – Retailer and Supermarket

Salling department and Føtex supermarket's back-of-house private waste bin area will be utilised for the FleXskrald project as the central hub for collection and compaction of waste before getting collected by Stena Recycling company to collect it from the inner-cities to the recycling centre in Nørresundby. The electric vehicles and the moped will also be parked next to Salling and this is where the electric charging station is. This is the extent of their involvement in the FleXskrald project (Quintero Hansen & Schultz Andersen, 2019).

<u>Final waste collectors:</u> Stena Recycling Company (Nørresundby branch) – Private company

Stena offers individuals and companies to sell materials for recycling. Currently, Stena receives iron, metal, hazardous waste, electronics, paper, cardboard and plastic to be sorted for recycling. They ensure circular economic principles by giving the recyclable waste a new life. These waste are sorted and collected and transported to the Stena Nordic Recycling Center in Sweden to be converted into raw materials for reuse by industries (Stena, n.d.).

Cost of FleXskrald services:

As shown in Table 11, the service fee does not differentiate between the weight of the waste but the number of collections. The fee was based on market rate. The recycling station also charge per visit. For example, a trailer costs 200kr per visit, resulting in the same price as FleXskrald's once a week service (Bro Bystrup, 2019).

Pick up of plastic and paper/cardboard time schedule	Cost
i.e. 2 bags of plastic and 1 bundle of cardboard	
Twice a week – Paper and Cardboard	400kr
Once a week – Paper and Cardboard	200kr
Collection of plastic – once a week	200kr

Table 11. FleXskrald services and costs (FleXskrald, 2019b)

There will be a free introduction period of three months that is available for the inner-city shops, with the option of flexible pick-up with an easy digital solution to ordering waste collection (plastic and paper/cardboard) (FleXskrald, 2019b).

Appendix B.2. Results from survey of 64 shops in the main pedestrian streets of Aalborg



Figure 20. Various collection schedule for paper/cardboard waste from the 64 shops surveyed on the pedestrian streets of Aalborg



Figure 21. Various collection schedule for plastic waste from the 64 shops surveyed on the pedestrian streets of Aalborg



Figure 22. Various categories of shops and businesses surveyed



Figure 23. Different sizes of 64 shops surveyed. Large shops are defined as over $100m^2$, medium shops are between $50-100m^2$ and small shops are less than $50m^2$



Figure 24. Out of the 37 respondents from the survey that provided information on cardboard/paper weight disposal per week. Left: Number of shops disposing cardboard/paper waste to six options available, Right: Total number of kilos of cardboard/paper weight disposed to six options available.



Figure 25. Out of the 37 respondents from the survey that provided information on plastic weight disposal per week. Left: Number of shops disposing plastic waste to six options available, Right: Total number of kilos of plastic weight disposed to six options available.

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