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The evolution of Norwegian Waste Management

An Investigation of Circularity & Financial Performance

Conducted in Collaboration With SAR

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The Evolution of Norwegian Waste Management –
An Investigation of Circularity & Financial Performance

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Abstract

Waste has over the years evolved from being seen as merely a burden, to being perceived as an integral part of a shift towards a sustainable and circular economy. This thesis provides an extensive description of this change, with specific focus on the Norwegian waste management industry.

As a high-income country, Norway has a high recycling rate compared to lower income countries. However, hazardous waste generation has inflated far faster than GDP and population the past decades. Hazardous waste is inherently complex to recycle, and as of today, difficult to combine with being profitable. As most of hazardous waste in Norway ends up at landfills, this spurred us on to examine if access to landfills had any effect on profitability.

The result from the regression fails to conclude that access to landfills have a statistically significant impact on financial performance, although the difference in means between the two groups came out significant. Thus, the results are not indicating a significant difference, but this could also be a consequence of a small sample size over companies with access to landfills. On the other hand, economies of scale prove to have a statistically significant impact on profitability in the waste management industry.

Table of Contents

Preface

This master's thesis marks the conclusion of our master's study at the University of Stavanger. We both spent the last five years in Stavanger and at the university, as it is where we also earned our bachelor's degree. For our master's degree we specialized within finance- and strategic marketing respectively.

We were fortunate enough to work together during our internship with SAR the fall semester of 2020. In spite of a challenging time by virtue of the covid-19 pandemic situation, we were able to gain a massive learning outcome. We also provided SAR with useful analyses and perspectives. Even to such an extent that it fell naturally to write our master's thesis in collaboration SAR. We will therefore take the opportunity to express our gratitude towards SAR, and especially our contact, Chief Strategy Officer Øyvind Osjord, who contributed tremendously to the success of our internship period and gave us invaluable support whilst writing this thesis.

Writing this thesis has been demanding in a positive sense. Our different backgrounds form our study has helped us bring different skillsets and perspectives to the thesis. We are convinced that the thesis brings relevant knowledge in the context of the waste management industry, particularly in a Norwegian context.

We would also express our appreciation to our supervisor Peter Molnar, who has given us valuable counseling and feedback throughout the process of writing this thesis.

1. Introduction

Sustainable development, where economic growth is combined with a rational utilization of resources, limited emission of greenhouse gases and protection of nature and local environments is arguably one the greatest challenges of our time. Waste, and the handling of it, is an essential part of achieving sustainable development, as it affects resource productivity, economy and impact on the nature.

A remarkably small number of studies have been conducted on how private companies in the waste management sector plays a part in a sustainable development. Most existing literature describe the municipal waste management in development countries. Therefore, this thesis enters a blue ocean, as it dives into the private companies that constitute the Norwegian waste management industry, and their outlook.

Firstly, this study describes how waste management evolves together with an economy. What is interesting about this angle, is that economies in different stages of maturity and prosperity, have formidably differentiated challenges related to the handling of waste. Secondly, we seek to place the challenges in the context of circularity and sustainability, with focus on Norway.

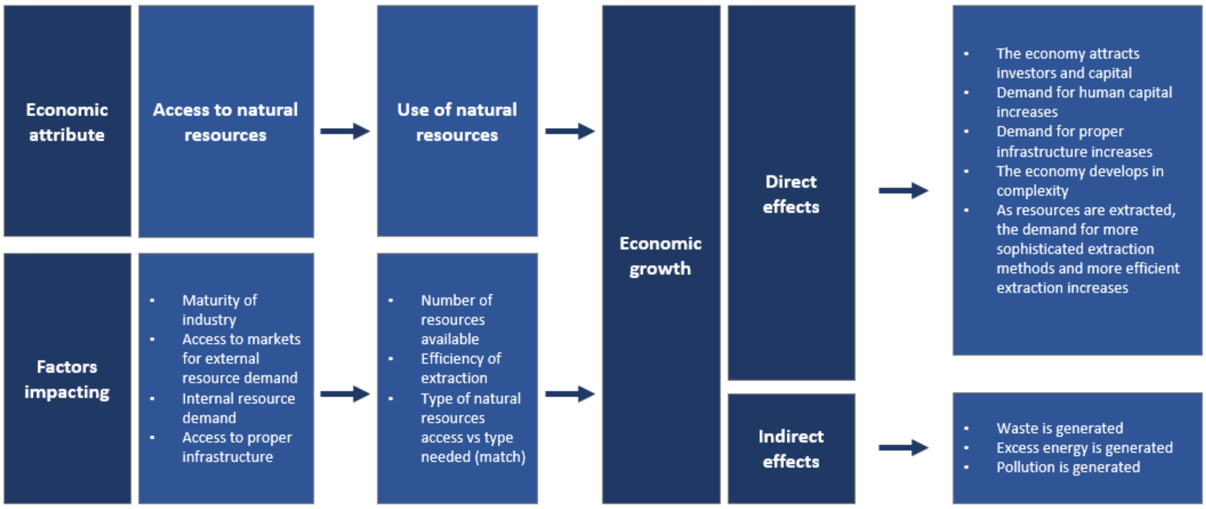
To become truly circular is demanding, and for high-income countries this requires less consumption, and also a substantially higher recycling rate than today's level. Therefore, we seek to unveil how a company's profitability is affected by access to disposal landfills. Furthermore, we want to investigate how size – proxied by revenue – affects profit. This is because we suspect that the companies which have access to landfills are typically bigger in size. Also, drawing in the aspect of economies of scales is interesting in itself.

2. Background

2.1 The relationship between economic growth and waste generation

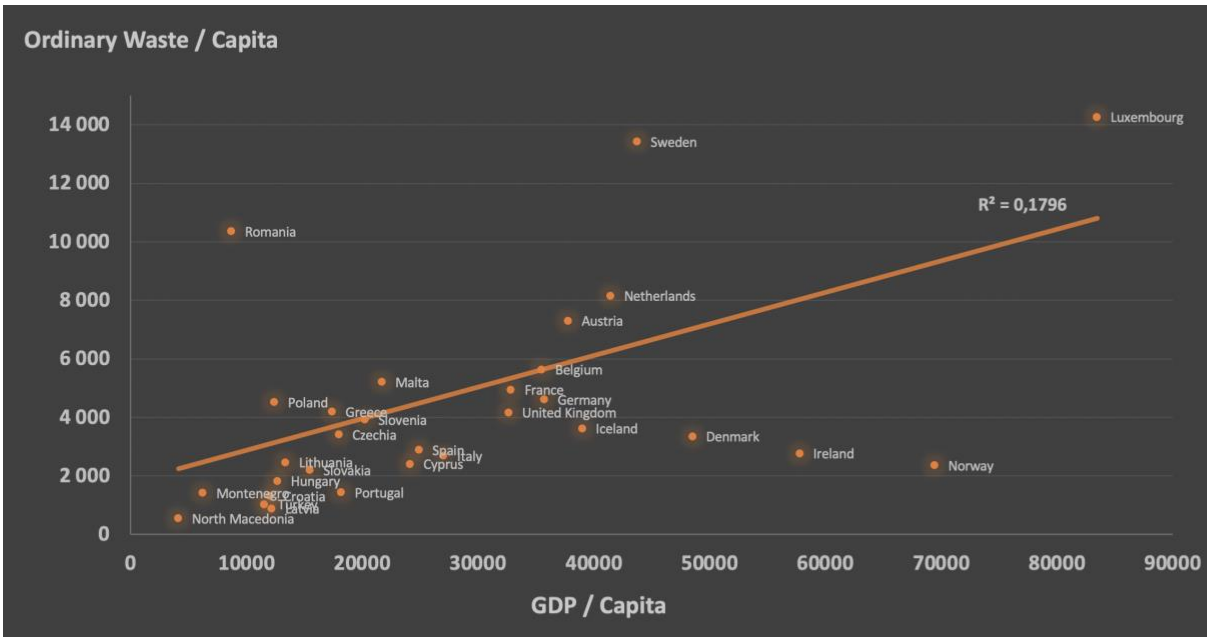
Access – and the ability to efficiently exploit natural materials and resources represent the backbone for economic growth (OECD, 2020), and countries across the world vary in access to the different materials needed to fuel prosperity. At the same time, economic growth relies on increased use of natural resources and energy – which in turn drives up waste generation from such extraction and use of materials and resources. Thus, alongside economic growth comes the intensified need for a proper waste management and treatment industry. Even more so – as resources become scarce, the importance of perceiving and handling waste pragmatically is emphasized. To understand this relationship and its impact properly, it is useful to consider the access to raw materials – and also the way a country manages its resources. Figure 1 illustrates how a country utilizes its natural resources to fuel economic growth, and the impacting factors to the efficiency in the process.

Figure 1: How Economic Growth Derives from Natural Resources



Following the logic from Figure 1, a country that utilizes its natural resources with intentions to grow, generates more waste, as this is considered a biproduct of economic growth. Researchers (OECD, 2020) have long proclaimed the robustness of the relationship between a regions GDP, and its waste generation rate. Among the European countries, the relationship between ordinary waste generated and GDP per capita is weaker than the relationship between hazardous waste and GDP per capita:

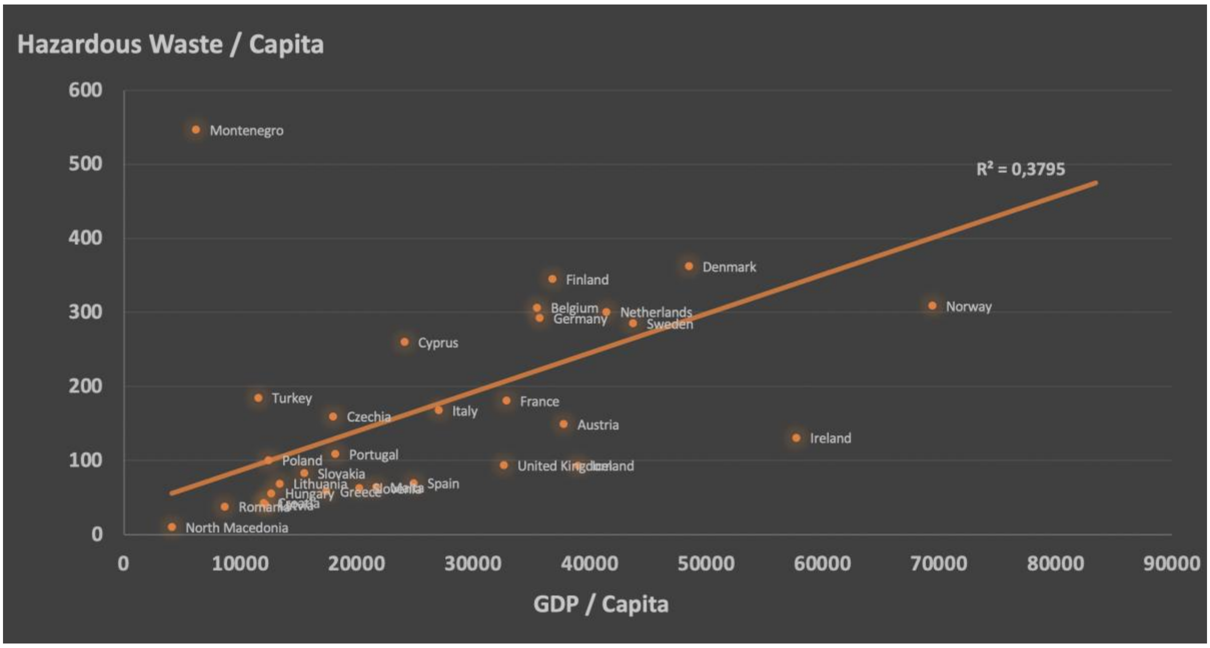
Figure 2: The Relationship Between GDP and Ordinary Waste



Source: Eurostat (2018)

Note: GDP / Capita is the specific country's Real GDP divided by the population. Ordinary Waste / Capita is total waste in kg divided by the population. Numbers are from 2018, which is the latest waste statistics available.

Figure 3: The Relationship Between GDP and Hazardous Waste



Source: Eurostat (2018)

Note: GDP / Capita is the specific country's Real GDP divided by the population. Hazardous Waste / Capita is hazardous waste in kg divided by the population. Numbers are from 2018, which is the latest waste statistics available.

There may be several reasons explaining this difference. One interesting fact relates to the increase in complexity of waste – mainly on the industrial and hazardous waste side of the waste sector. As the industries grow, and economies become more developed, the use of chemicals and other complex input factors in industrial processes increase, and consequently, so does hazardous waste volumes. Thus, the requirements for sophisticated and technical treatment methods also emerge.

Figure 4: Evolution of an Economy, Waste and Material Productivity

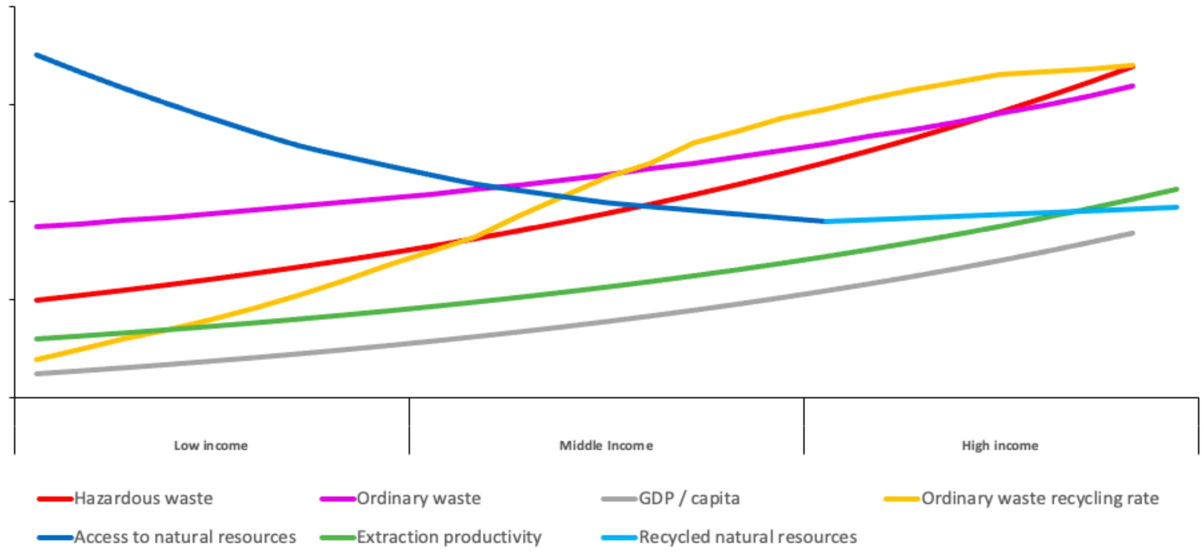
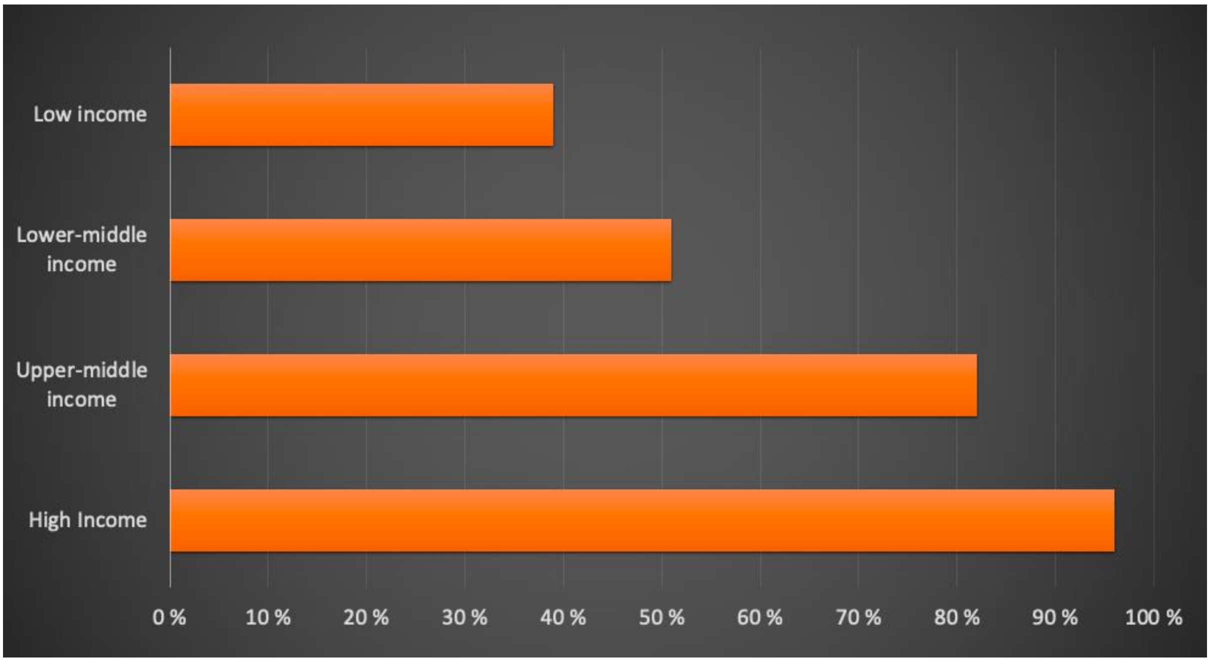


Figure 4 shows how an economy develops in terms of GDP, ordinary vs hazardous waste generation, and recycling rate. As the access to natural resources are depleted through the growth cycle, the rate with which ordinary waste grows is in-line with the findings of OECD (2017), whereas the hazardous wastes increase exponentially compared to GDP.

In the early development stages of the economy (typically when the economy is defined as a low-income economy), economies typically tend to exploit its resources using whatever technology is available. As the economy starts to prosper from the extraction, however, the demand for more sophisticated extraction – and more efficient extraction (defined as ability to extract more output per unit of input), increases. This is typical for the stages where an economy may be defined as a "middle income economy" and can be seen in Figure 4 through the waste resource productivity. Resource productivity can be tracked through looking at GDP per unit of resource consumed. The OECD uses the measure Domestic Material Consumption (DMC) as a measure of natural resource reserves usage per time unit (OECD, 2017).

The world's Municipal Solid Waste (MSW) has seen an increase in volume over the last decades, where developed countries and their rising level of consume are the biggest contributors to this. Dumps and landfills are massively dominant amongst treatment methods as this is where 70 percent of global MSW end up. Naturally, this means that most of the waste is not reused as part of a circular economy, which causes a strain to natural resources. Also, there are emissions that come along with the extraction of new materials, impacting the carbon footprint from production of goods. Dumps and landfills are also a threat to the local nature and wildlife, in particularity those that are not administrated as sanitary landfills. (Chen, Bodirsky, Krueger, Mishra, & Popp, 2020).

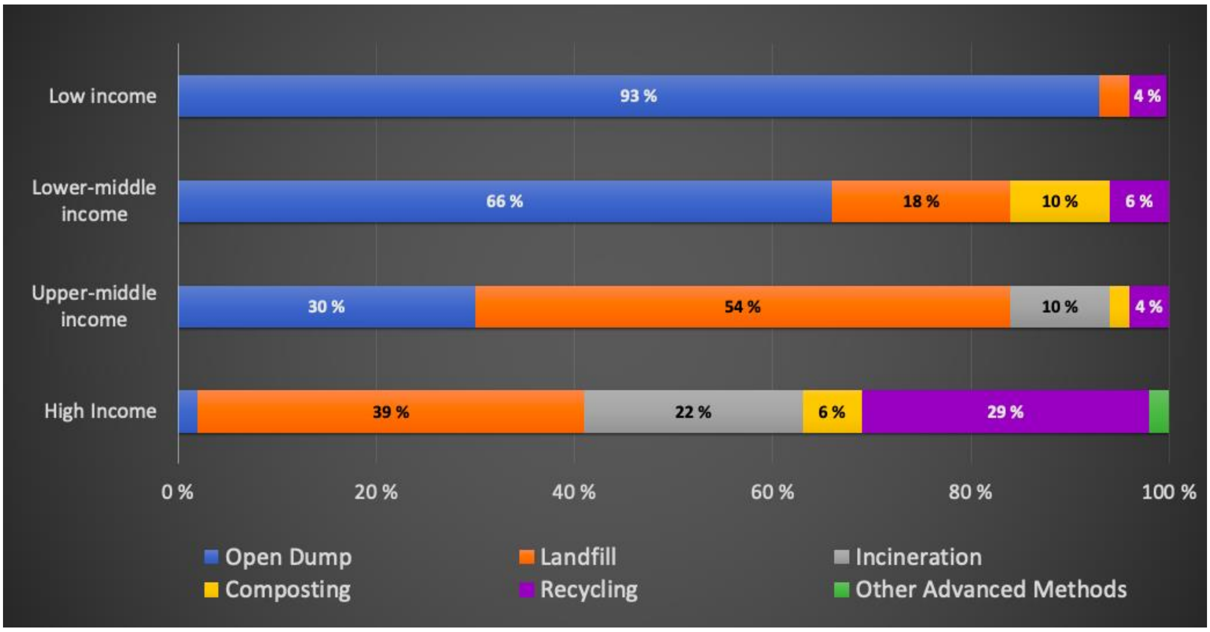
Figure 5: Waste Collection Rates by Income Level



Source: What a Waste 2.0 (Kaza, Yao, Bhada-Tata, & Woerden, 2018)

The report What a Waste 2.0 (Kaza, Yao, Bhada-Tata, & Woerden, 2018) provides further information about global waste trends that are useful, compiling data from the last two decades. As Figure 5 shows, country income and collection are strongly correlated. Also, differences are considerable in terms of disposal methods, looking at groups of countries with different income level. Whereas higher income countries largely manage to avoid the unfavorable dumps and have a recycling rate many times higher than the other groups of countries. The incineration rate also stands out as pretty high, especially compared to the groups of countries. However, for the most developed countries, over one third of the collected waste is ending up at landfills. In the context of circularity and the green shift, these numbers indicate that there is still potential for improvement to become truly circular.

Figure 6: Disposal Methods by Income Level



Source: What a Waste 2.0 (Kaza, Yao, Bhada-Tata, & Woerden, 2018)

Note: The difference between open dump and landfill is that landfills are controlled, monitored and regulated to different extents, whereas open dumps are only piles of waste.

The global trends of MSW show that countries in distinct stages of development have unique challenges related to waste. It also seems obvious that as a planet, there is a long way to go before a circular economy is fully implemented. Also needed to be taken into account, is that poverty has plummeted at a frantic rate. From 1990 to 2015 global extreme poverty rate has dropped from 36 percent to 10 percent. All the while several of the United Nation's 17 sustainable development goals are closely linked to lifting people out of poverty (United Nations, n.d.), balancing sustainable growth economically and environmentally can prove to be a massive challenge.

In point of fact, scientists dispute whether or not the economic growth can continue sustainably. Economist Linnerud and professor in renewable energy Holden (2016) criticize how the sustainability term is applied in UN's Sustainable Development Goals as very vague. Furthermore, they argue that economic growth is inherently not environmentally sustainable, and that United Nations have created this angle to make sustainability acceptable for a greater audience. On the contrary, Zuo & Ai (2011) indicate that sustainable economy is in fact possible provided that technology allows for more effective use of energy. Adding to this, by logic one cannot rule out the possibility of sustainable economic growth as the technology of tomorrow is unknown as of today.

Natural resources are of course scarce. Although demands, extraction methods and technologies change, natural resources are finite. The amount of natural resources extracted and consumed globally was about 75 gigatons as of 2010. That is ten times the amount from 1900, and twice as much as in 1980. That number is expected to be 100 gigatons in 2030 as the global economy grows. (OECD, 2015).

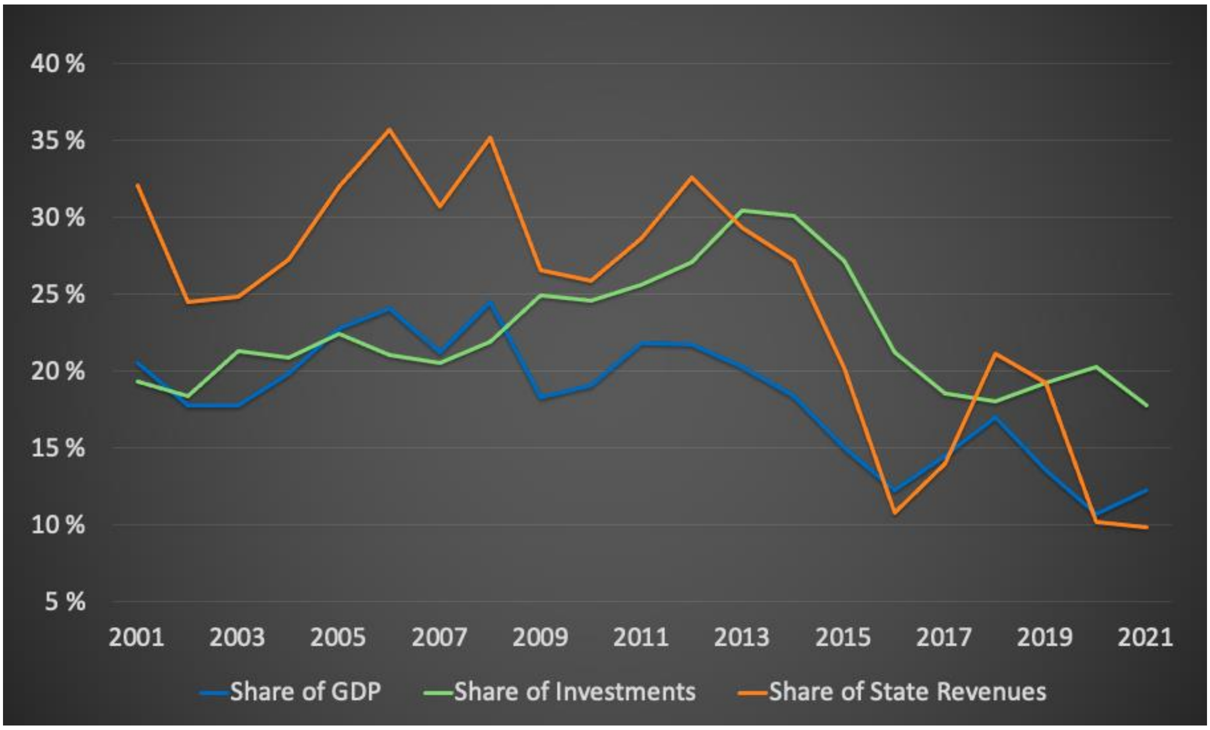
More efficient use of resources demands both focus on circularity and increased awareness around new value chains. Reusing, repairing, improving and recycling in a cycle where fewest possible resources are lost is the basis of circular economy. In such a system, waste is a valuable resource, not a problem. CO2 emissions linked to a production process can also be such a resource to be used as an input factor in businesses in the value chain. The effort to upscale solutions that build on a circular economy, needs to intensify. This means that companies must take responsibility for their own waste streams. (The Confederation of Norwegian Enterprise (NHO), 2018).

2.2 Why the Norwegian waste management industry?

The rationale behind looking deeper in the Norwegian waste industry is twofold. Partly it is due to our internship spell at SAR, where we gained a unique insight to the company as well as the industry. Not to mention a great interest in the challenges facing the industry at this point in time. Furthermore, there are abundant aspects to the Norwegian waste management industry that are explicitly interesting to investigate.

For example, the petroleum industry is Norway's biggest measured in GDP, state revenue, investments and export value. The last 20 years, the share of total state revenues from the petroleum industry averaged a 25 percent (Norsk Petroleum, 2021). Moreover, despite the growth in demand for renewable energy, oil and gas is still forecasted to provide 50 percent of the world energy need in 2040. By then, energy demand is estimated to be 25 percent higher than today. (OPEC, 2019)

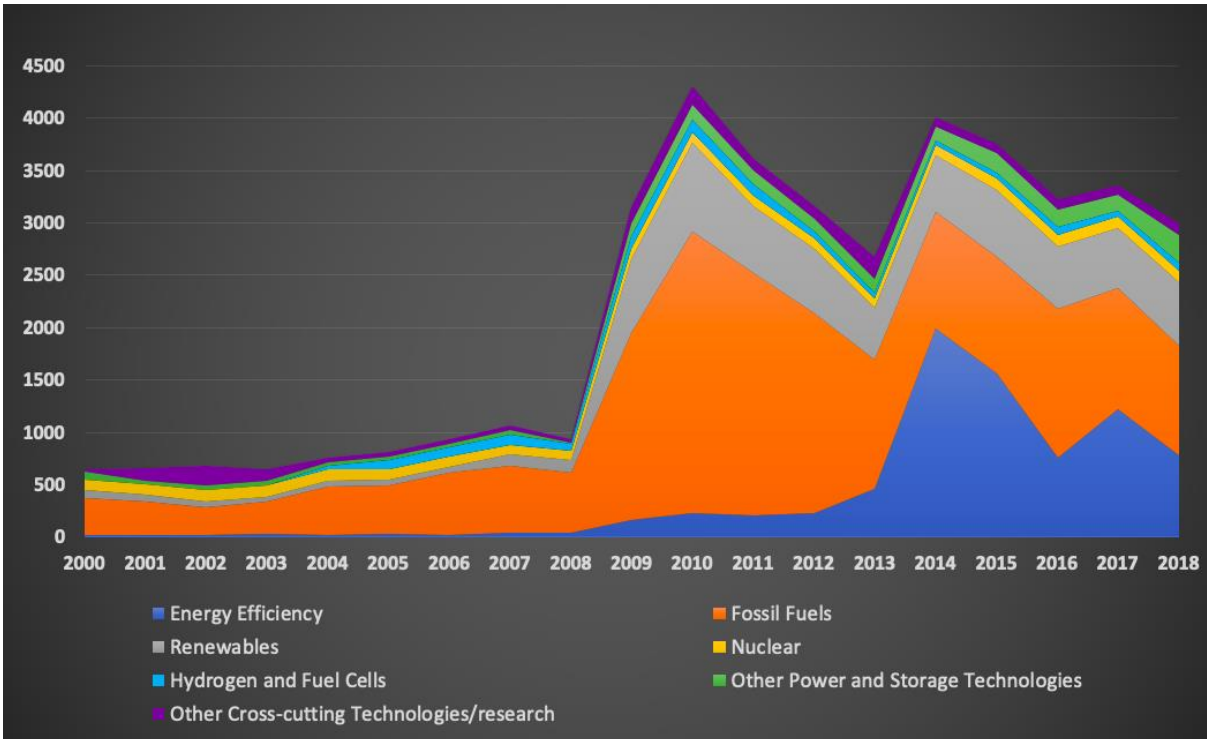
Figure 7: Macroeconomic Indicators for the Norwegian Petroleum Sector



However, it has been debated whether Norway actually could benefit from transitioning from a petroleum dominated economy to investing in green industries, such as hydrogen, offshore wind, carbon capturing and batteries. (Kattel, Mazzucato, Algers, & Mikheeva, 2021) point out that private companies are in fact key in such a transition, and that the state could serve as a facilitator through financial regulations. Additionally, Kattel et al. (2021) underline how a reallocation of innovation funds and state involvement can be a turning point in Norwegian economy, parallel to the industrial revolution early from the early 1900's and the findings of oil- and gas reserves 50 years ago.

Not to be unmentioned, one solution does not necessarily entirely rule out the other. Norway is already investing in renewable energy and Norway could end up with a solution where both the petroleum- and green industries are backed by the state. In the end, it becomes a question of alternative cost. Looking at figure 7, the Norwegian Government's R&D budget, has changed in favor of alternative energy sources over fossil fuels. Overall, the budget has more than quadrupled from year 2000 until 2018. The share for fossil fuels has decreased from 54 percent to 35 percent. Drawing any conclusions from this data is difficult, as there are valid arguments in favor of both scenarios. Yet, it naturally explains something about the government's ability to invest in multiple energy sources. Also, it is clear that the commitment to R&D investments has strengthened, especially the last 10 years. (IEA, 2021)

Figure 8: Norwegian Government R&D Budget by Technology



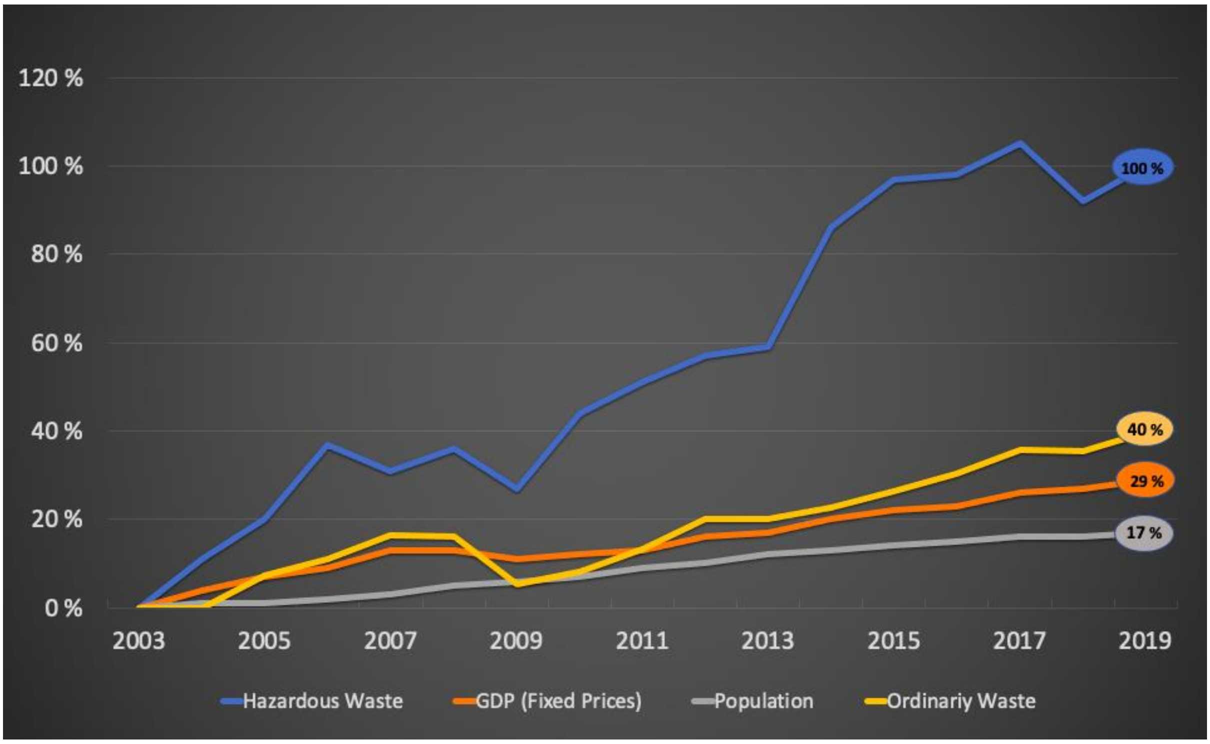
Note: Stated in MNOK (2019 price)

According to The Norwegian Environment Agency (NEA) (2021) the total amount of waste in Norway has increased by 40 percent from 2003 to 2019. The amount of hazardous waste has risen even faster, doubling over the same 16-year period. In comparison, the population growth stops at only 17 percent. The expansion in GDP, however, is 29 percent (Norway, 2020). Growth in both the economy and in private consumption causes bigger volumes of waste, as confirmed by the NEA (2021).

As a consequence, the market for waste management services has inflated in respect of demand. The NEA (2019) as strict regulations regarding treatment of waste, which means that companies that produce waste, by law are forced to make sure that the waste is taken care of in a correct manner. Furthermore, since the start of 2016, Waste Regulations (2015) requires financial security from all companies receiving and storing hazardous waste, ensuring safe handling of such waste in the case of stops in the activity, liquidity issues and other unforeseen events.

The growth and the regulations together presumably constitute very beneficial prerequisites for the industry to thrive. However, it is unknown if these two factors explain the increased value of the market and number of players.

Figure 9: Development of Waste, GDP & Population in Norway



Moreover, the companies within these markets have had a change in outlook. One aspect is that waste managers face new and bigger expectations and demands from stakeholders such as consumers, shareholders and partnering firms, as well as requirements from governments. As The Nordic Competition Authorities (2016) point out, waste has been subject to a change in perception from governments, companies and society in general. Over the last decade or two, waste has to a larger extent become a resource instead of merely a burden.

2.2.1 National Waste Plan Norway 2020-2025

Looking further to Norway, a national goal is that the growth in waste volumes should be considerably lower than the economic growth, and that the resources derived from waste is utilized in the best way possible through material recycling and energy production. National goals for waste are for the time being under assessment, also referring to the parliament communication that waste politics and circular economy that the government intend to investigate the consequences of adding to the national objective for recycling with own targets for material recycling. A national strategy for circular economy is also being prepared. (NEA, 2019).

Alternative recycling is defined as waste that is utilized in a manner that is not entirely recycling or reusing. This can e.g. be when concrete and other mineral waste forms are replaced by other masses for filling and similar purposes. Permits from the contamination authorities are required if the measure can lead to contamination. (NEA, 2019).

In a report by InErgo (2018) on behalf of NEA, the outlook on the future of hazardous waste in Norway is assessed. Different measures to incentivize recycling hazardous waste are investigated. The report concludes that in the scenario that all of the measures work at full effect, the recycling rate could rise from 8 percent to 14 percent, adding up to 225 000 tons. The report also states that these numbers are low. Compared to the recycling rate of non-hazardous waste, with a recycling rate of above 40 percent the last years (Statistics Norway, 2019).

As implied by Bresnahan (1989), highly concentrated industries tend to contribute bigger market power to the players. This is hardly controversial, as it aligns with basic microeconomic theory with respect to the dynamics of supply and demand (Eastin & Arbogast, 2011). Drawing from this, increased competition will by logic reduce market power. Hence, a question of interest is what challenge this imposes on the players of the waste management sector.

The buzzword *circular economy* is interesting to consider when beholding the waste industry, because it symbolizes how crucial these companies are in the context of achieving sustainable economic growth. The entire sector is challenged on a lot of areas by this relatively sudden change. Focusing on circularity means reducing the big share of waste that ends up at landfills, or even better, higher rates of recycling. The focus on that kind of innovation has intensified and requires a different kind of competence. Also, the branding aspect of the business is shifting towards the interest in circular companies. Illustratively, some of the big waste management players have slogans that reflect this. SAR's slogan is *Turning waste to value*, Ragn-Sells has *Part of the cycle* and Norsk Gjenvinnng uses *Waste does no longer exist*.

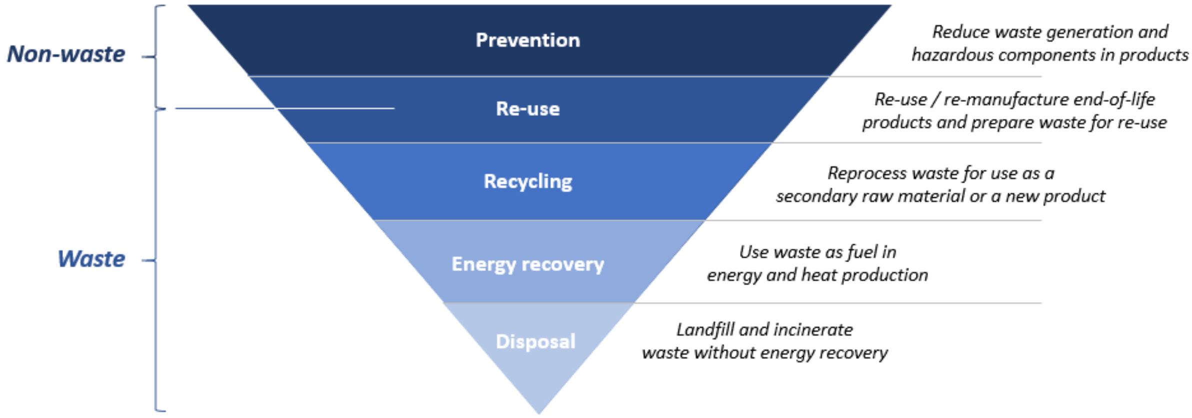
Waste Association Norway (n.d.) underline that the industry has evolved from predominantly collecting and handling waste. Now, the players that make up the industry also produce, distribute and sell recycled materials, fuels and natural resources amongst other activities. Indications point in the direction that this transformation will only progress. The waste hierarchy (Figure 10) connects with the shift of focus towards productification.

The share of waste going to landfills has increased from 13 percent to 19 percent from 2012 to 2019, as seen from Figure 14. Nonetheless, landfills have managed to reduce their share of emitted CO_2 -equivalents within the waste management industry. This is due to heavier regulations and improvements the last years. So, from 1,29 million tons CO_2 -equivalents in 2010, landfills contributed to only 0,87 million tons CO_2 -equivalents in 2019. Namely, a reduction of 48 percent despite growing volumes (NEA, 2020). However, landfills have negative impacts on the local environment, in addition to poor resource utilization. On the contrary, landfills produce a bit less greenhouse gases than incineration. As a total, landfills are still considered by the industry to be the least favorable option for treatment. Partly because it is harmful to nature in close proximity, because it still produces a lot of greenhouse gases, with no output in return, and does not harmonize with the reformation towards a circular economy.

2.3 The Waste Hierarchy

To best understand how economies shift their work to increase resource exploitation at this stage it is useful to use the OECD's (2020) waste hierarchy model, where waste reduction and re-use, and excess energy exploitation are key contributors:

Figure 10: The Waste Hierarchy



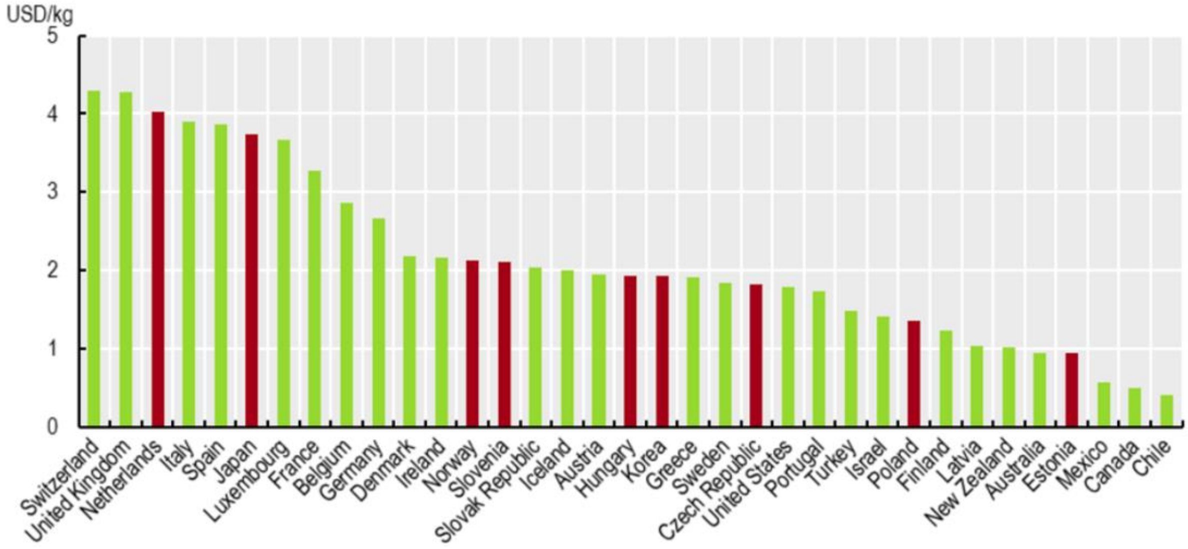
Source: (OECD, 2020)

The first two layers, waste prevention and part of the re-use area, are mainly driven by the overall market of consumers and companies in an economy, whereas the below levels require the waste management industry to adapt.

2.3.1 Waste Prevention and Reuse

In order to optimize resource exploitation as an economy enters the high-income stage, economies must learn to decouple waste generation per unit change of GDP per capita. Several countries that may be defined as either in the middle- or high-income buckets today have already started this process. The OECD (2017) found that both countries like Japan and Poland has successfully managed to grow GDP more than overall waste generation. Norway – on the other hand, has not yet managed to start this decoupling, and the OECD (2017) state that between 2004 and 2011, Norway grew waste generation by 17 percent and GDP by 9 percent. Figure 3 explains how Norway still struggles to decouple hazardous waste from GDP growth.

Figure 11: Resource Productivity for OECD Countries



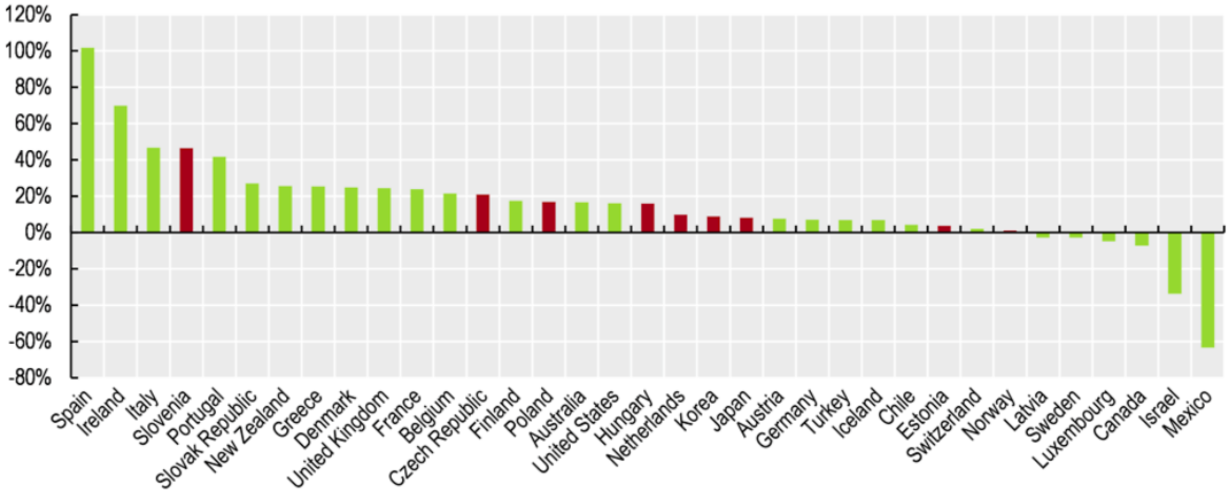
Source: OECD (2017)

Note: GDP per Unit of DMC, 2015.

Norway – which is considered a "high income" country, appears in the middle part of the sample of material productivities in OECD countries (Figure 11). This may be an indication of how far Norway has come in terms of linear resource value creation efficiency. Linearity in this sense refers to how Norway is able to exploit its resources from extraction to use, without considering how the economy is able to re-create value from the resources after initial extraction or use.

Looking at how the GDP per unit of DMC has developed over time, as is illustrated in Figure 12, we see that Norway is one of the countries with the lowest growth rate among OECD countries. This may be an indication that Norway is close to reaching its maximum value creation per linear resource consumption. This prompts interest for looking into how the Norwegian economy now may turn towards circular resource value creation efficiency – which may drive both re-use and recycling rates.

Figure 12: Resource Productivity Growth (2008-2015) for OECD Countries

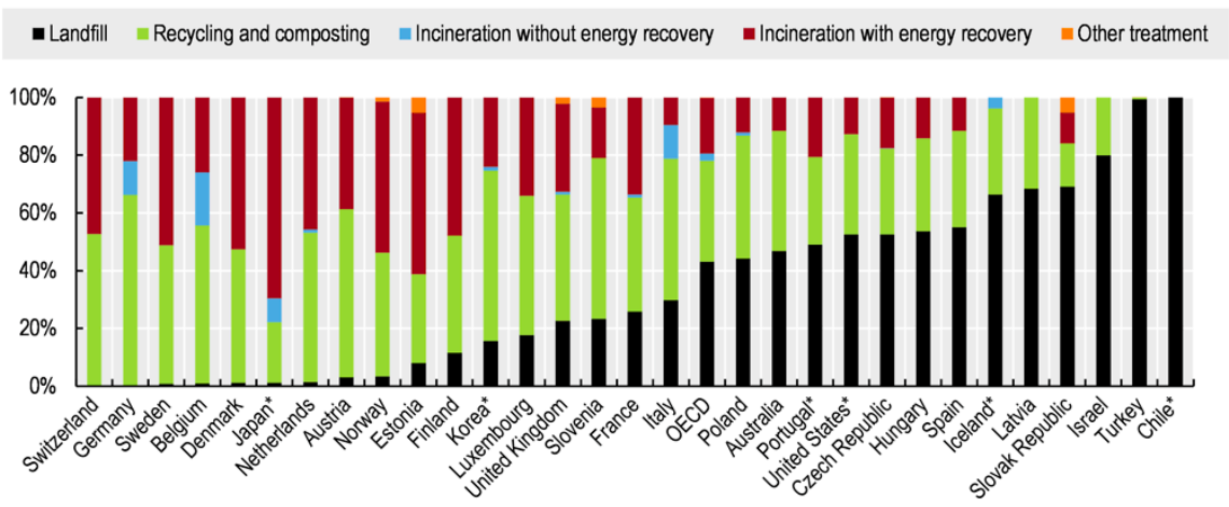


Source: OECD (2017)

2.3.2 Waste Recycling, Waste to Energy and Waste to Disposal

Following the observations from Figures 2 and 3, and the arguments explained in Section 2.1, it is expected that as economies grow towards a "high income" state, both their resource extraction as well as exploitation increase. Part of this is related to technological development, where countries will need to access or develop increasingly sophisticated treatment and sorting methods to succeed in re-using or recycling as much of waste, energy or pollutants from industrial processes and municipal living as possible.

Figure 13: Treatment Methods of MSW for OECD Countries

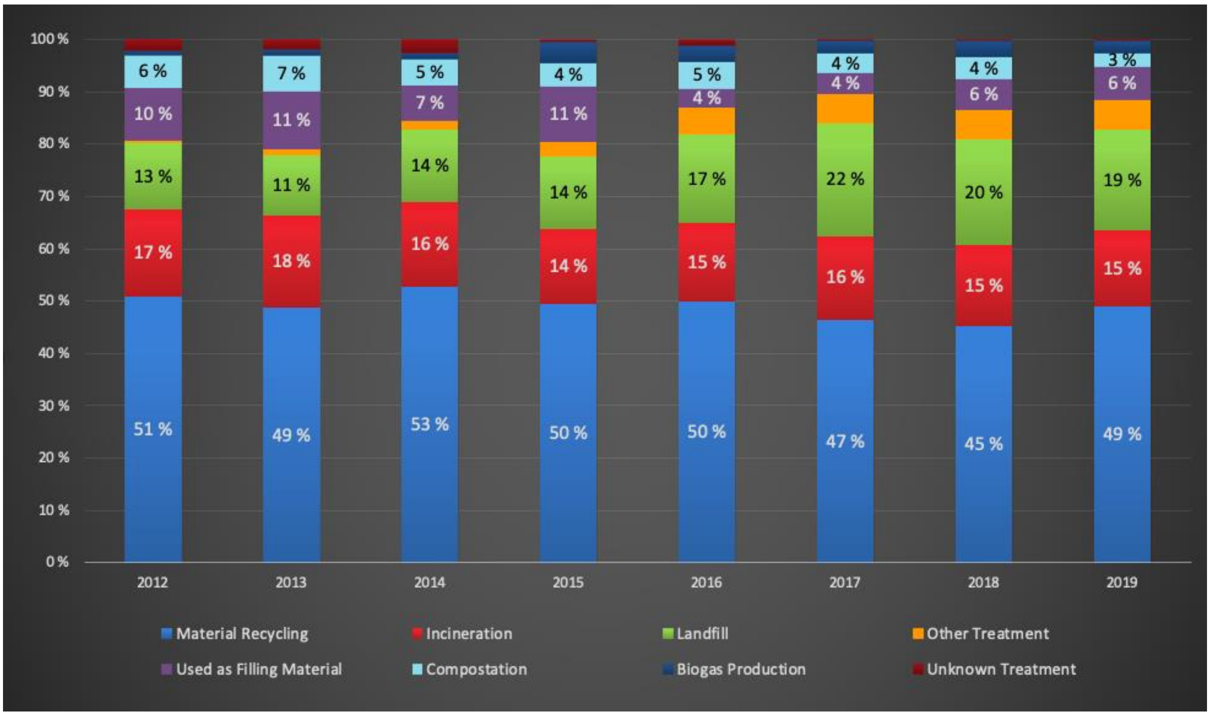


Source: OECD (2017)

Note: Data from 2015.

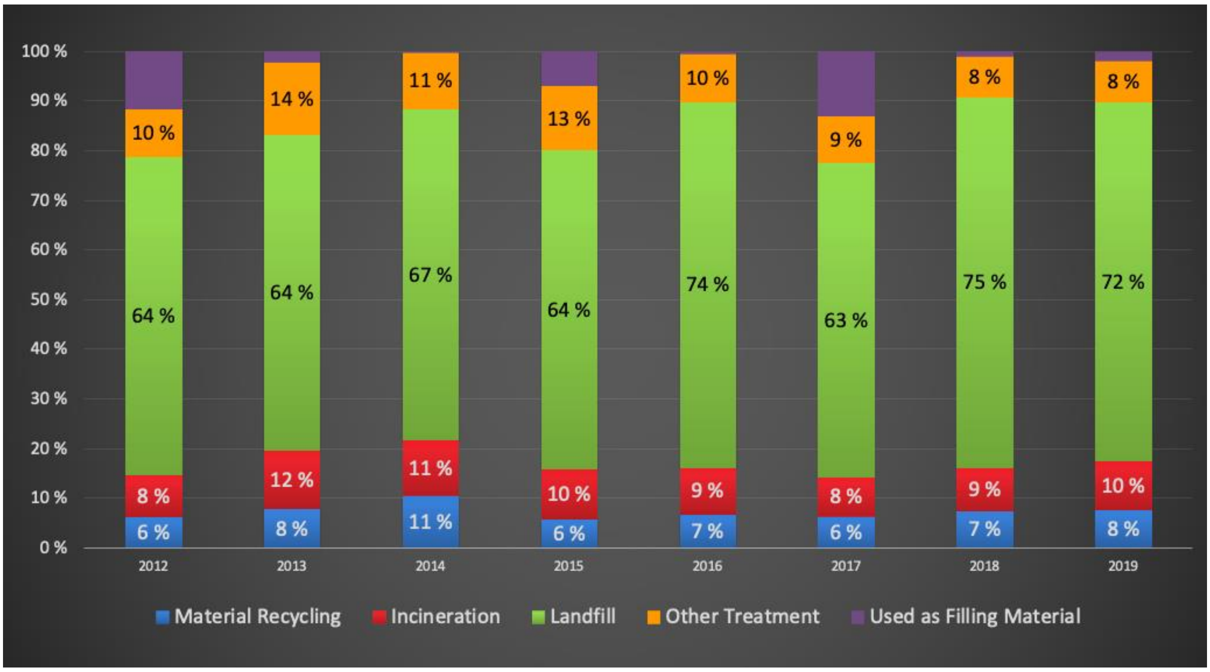
As can be seen in Figure 6 above, we see that most of the “high income” countries of the OECD have succeeded in reducing MSW sent to landfills to a bare minimum. Recycling and compositing – as well as energy recovery, takes over as key elements to treatment.

Figure 14: Development of Ordinary Waste Treatment in Norway



Looking at Figure 14, we see how the handling of ordinary waste in Norway has developed over time, as the economy grows (proxied by GDP), the recycling rate is improved. However, the share of waste ending up in landfills increases equally as much as the recycling rate. Either way the development has, by all accounts, stagnated. This supports the arguments above; that Norway seem to have reached a level of resistance in terms of positive circular development for waste.

Figure 15: Development of Hazardous Waste Treatment in Norway

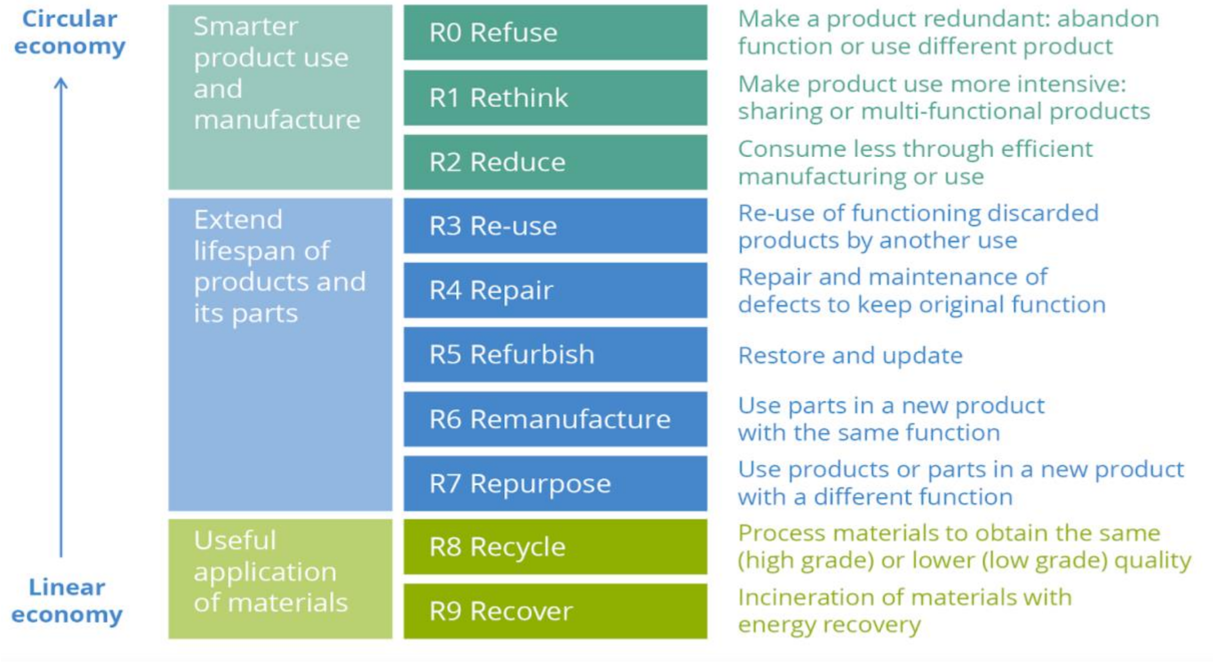


Looking at Figure 15, we see that Norway has seen an increase in relative amount of hazardous waste sent to disposal landfills from 64 percent in 2012 to 72 percent in 2019. This may be explained by a treatment technology gap in Norway as exemplified by the oils disposed at NOAH – but which can be treated and re-used in other European countries. Comparing Figure 15 to Figure 14, it is clear that the hazardous waste segment has far more potential for improving both landfilling and recycling rate.

2.4 The Circular Shift

The explained factors above help underline how economies move from linearity (meaning extraction-use-disposal) towards a circular economy, where resources are considered in an eternity perspective – and resources that cannot be re-used are taken out of the industrial and product cycles in the economy.

Figure 16: Strategies in a Circular Economy



2.4.1 The Circular Shift in the Norwegian Markets

Solving the climate crisis is challenging, but it also opens up an abundance of opportunities for companies to take the lead towards a sustainable future. The recent years, IPOs in Norway have been with an increasingly high share of environmentally focused companies. Approximately one out of four newly listed companies on the Norwegian stock exchanges Euronext Growth and Euronext Oslo were considered green in 2020 (Oslo Stock Exchange, 2020; Slettedal, 2020). A handful of them are within the waste management industry.

Companies in this sector has been perceived with lower level of interest up until recent times. One of the reasons might be the perception that transporting and collecting waste is not as lucrative as an investment in other parts of the value chain. The waste management industry has for a long time been seen as the lowest value chain level for any industry. Now the sentiment is shifting towards it becoming more important, as it is evolving to be a reproducer of resources, and supplier back to the value chain. This transformation is fueling a movement – where turning waste into value throughout the entirety of the waste stream is a success factor. The new taxonomy, with the circular economy being one of its main pillars, might push companies to enter this industry with innovative solutions to the climate problem. One should expect more companies taking these opportunities going forward and, in need of capital, seeking help from investors on the Exchanges. (Furuseth, 2020).

As of lately, the environmental focus has seemingly experienced a boost. Since year-end of 2019, the total market value of the green stocks on the Euronext Oslo exchange has more than doubled. From being as little as 4,2 percent of the total market value in 2019 to 8,3 percent at the end of 2020, we can safely say that the green focus has accelerated. Although, experts have criticized the tremendous growth and fear we are witnessing a green “bubble” in the financial markets (Lorch-Falch & Sættem, 2020). On the contrary, the oil and gas stocks have fell from above 50 percent to around 23 percent of the total market value. This also a strengthens the view of a green shift in the Norwegian stock markets. (Oslo Stock Exchange, 2020)

The four companies Agilyx, Cambi, Pryme and Quantafuel are the waste management companies enlisted on Euronext Growth the recent year. The objective for these companies is to recycle plastic and organic waste, effectively reducing volumes of waste entering landfills and disposal sites, thus keeping waste longer in the value-chain for re-usage (Euronext, 2021). There are several other trends which suggest Norway is heading in a greener direction. Nysnø Klimainvesteringer – a state-owned investment company that aims to invest in private companies that are operating to solve environmental problems, has since its inception in 2018 deployed close to 1 bn NOK in the market through green investments (Nysnø Klimainvesteringer, 2021). Other public agencies supporting green innovation and solutions are Klimasats, an arrangement by the NEA, funding municipalities for reducing their emissions. Also, there is the Green Platform Initiative, which subsidizes research institutions and companies in projects related to green growth and restructuring. However, Kattel et al. (2021) pointed out that there is a lack of coordination between these agencies and institutions in terms of successfully supporting the green industries.

This reinforces the fact that the waste management industry in Norway is of particular interest in our thesis. As a high-income country, Norway is one of the countries with the highest recycling rate and lowest share of waste sent to landfills or waste dumps. Norway has also been a pioneer within the transition from fossil to electric cars and are more than self-sufficient with reusable energy sources. From being a country with a significant exposure to the oil and gas industry, Norway have become a leader in the shift towards a sustainable, green future, although there is still some way to go before this is achieved.

2.4.2 Taxonomy and its impact on Waste Management Industry

The EU have lately been working on a framework called the Taxonomy – a classification system which determines the scope of which activities can be considered to be supporting a low-emission, climate resilient economy. In other words, it decides which activities are environmentally sustainable, and which that are not. This plays an important role in the Paris Agreement and the goal of a carbon neutral world by 2050 and a 50-55 percent emission reduction by 2030. The transparency and control the Taxonomy provides, will help investors make greener investment choices and increase the accountability of both investors and companies. Activities are followingly assessed by their environmental harmfulness with the goal of transforming into a circular economy which involves more recycling and waste prevention. (Technical Expert Group, 2020).

To fulfill the requirements of the taxonomy the activities must; i) Contribute substantially to one of the designated six environmental objectives (Figure 17), ii) make no significant harm to the other five objectives, and iii) comply with minimal guarantees.

Figure 17: Environmental Objectives for the Taxonomy

Source: (Technical Expert Group, 2020)

The Taxonomy seeks to phase out activities that are not contributing to climate change mitigation or causes a significant harm to at least one of the other five objectives. The phase-out determination is often based on the carbon intensity in the form of CO2 emissions equivalent per unit of electricity produced. Amongst these are the waste-to-energy incineration activities which almost doubles the EU28 average of carbon intensity of energy production. In addition to the high carbon emission, it fails to contribute to a transition to a circular economy and waste prevention. (Vilella, 2019)

The exclusion of waste-to-energy recovery through waste incineration have been a controversial subject amongst industry experts. Experts have been debating that much of the waste cannot be recycled or re-used and is thus most efficiently incinerated for energy generation. In addition, several EU members still landfill more than 40 percent of their waste, that produces methane which is 86 times more potent than CO2. Thus, the critique is focused around generating energy from residual un-treatable waste. On the other hand, this does not incentivize innovation and can also lead to more lock-in investments that undermine the environmental goals and in turn discourage reusability and recycling. (Recycling Magazine, 2020; Vilella, 2019)

The taxonomy is based on environmental performance thresholds. By that it will contribute to a greener economy as green financing is promoted, and companies are rewarded for taking the extra costs of taking the step towards sustainability. In the waste management industry, this can significantly change the recycling rate for the better. As we have pointed out the lack of incentive models for recycling rather than landfilling, the taxonomy with its requirements could stimulate to a change in favor of recycling. In the context of circularity, environment and nature preservation, this is crucial.

3. Literature Review

3.1 Financial Performance

Financial performance for various industries and countries has been widely studied. The research within this field is mostly of a quantitative nature and often tests common factors' impact on the profit of companies and industries. The results tend to vary across firms, industries and countries (Capon, Farley, & Hoenig, 1990). Within the waste management industry, the financial performance has been researched in fractions of the industry. It is primarily financial performance within the public sector that has been investigated in several regions of the world (Klase, 1995; Lohri, Camenzind, & Zurbrügg, 2014; Nishane & Bhalerao, 2015). However, there is still need for further research on financial performance in other parts of the WM industry, especially in the private sector.

Studies from Italy analyzing solid urban waste management companies in over 900 municipalities across the country, focused on the return on investment and return on equity to measure financial performance (Bartolacci, Soverchia, & Zigiotti, 2018). The productivity was measured as revenue per employee and production cost divided by production value, whereas the output is the productivity per employee and the core business efficiency. What was also assessed, was the financial stability by net equity divided by total assets, which indirectly measures of the debt-to-equity ratio.

Moreover, the relationship between environmental- and financial performance was measured by Bartolacci, Paolini, Quaranta, & Soverchia (2018) by dividing revenue on waste collected and population, respectively. The results would reveal information on companies' degree of efficiency, taking into consideration the costs carried by the population who are the consumers. Results backed up previous research, which pointed out that collecting waste is very expensive due to transportation costs. However, having treatment facilities and possibilities for recycling made potential for increased revenue and a better relationship between the revenues and costs.

Cucchiella, D'Adamo, and Gastaldi (2014) argues that financial performance is increased by correct environmental management, because waste investments provides both environmental and economic benefits. However, a problem arises when high amounts of waste can't be recycled due to technology constraints and needs to be landfilled or incinerated. On the other hand, this gives incentives to innovate and treat the remaining fraction of the waste in other ways, leaving potential for further economic benefits in terms of profit and employment in addition to environmental benefits.

Another study looked at the relationship between corporate social responsibility and financial performance, in which they found that size and risk, amongst other factors, were important control variables since these variables typically have an effect on financial performance. (Andersen & Dejoy, 2011).

3.2 Waste Management Industry

Few studies have investigated the WM industry in Norway. A recent study was done focusing on the implication of a new ISO standard in Norway. The study investigated if the implementation of the new ISO standard would help improve the sustainable performance for the solid waste sector. Additionally, the current waste management situation was qualitatively analyzed in the solid waste sector. (Hage, 2016).

The hazardous waste sector is not widely studied at a global level. However, a study from Europe looked at hazardous waste generation and the strategies for handling it. The issue of incomplete data and reporting differences across countries is underlined. In addition, the data was gathered over a period where there were several changes in awareness, definitions and classifications of hazardous waste. Despite this, the correlation between GDP and waste from construction, manufacturing, municipal and hazardous sources, were all correlated to GDP per capita. In particular, hazardous waste came out strongly correlated. These findings are in line with what is shown in Figure 2 and 3. (Popov & Pusch, 2006)

The recent focus on the environment has caused a debate around waste types that cannot easily be recycled or re-used as of today. These waste fractions typically get incinerated or landfilled. The volume of literature on landfills have increased in the recent years, as the environmental impacts of this treatment method have become more interesting. Several studies focus on various harmful substances that affect landscape, air, water and soil from landfill disposal sites and the importance of the monitoring related to this. Only a few landfill disposal sites are considered “sanitary”, even in a global context. Sanitary landfilling is a safer and also more expensive method.

Furthermore, the study highlights that landfilling waste should be a last resort treatment solution due to inefficiency and environmental reasons. However, the capacity issues which most countries face are pointed out. The conclusion is that landfills cannot be neglected, at least not in the near future. Therefore, countries must increase the standards and quality of the landfills. (Vaverková, 2019).

3.3 Literature Gap

The waste management industry is huge, but most of the research areas are related to specific countries and often at a municipal level. In addition, the hazardous waste sector is relatively unexplored compared to the ordinary waste sector. One important reason for this could be the differences in classification and reporting standards across regions, which again affects the availability and robustness of data. Furthermore, the WM industry of Norway has only been researched in small fractions and mainly at the municipal level. Also, despite Norway's high involvement in oil-related activities, research on the hazardous waste sector is very limited. This is also the case for research on landfill disposal sites. In addition to this, few financial performance measures have been studied in this industry.

3.4 Research Question

As an economy grows, so does access to technology, human capital, financial capital and infrastructure. The efficiency of resource extraction depletes reserves at such a rate that the economy adds focus to its priorities in terms of efficient use of resources. This is typical for economies of countries in the "high income" stage, where the economy shifts focus from extraction efficiency to exploitation efficiency. This is when an economy also turns its focus toward the biproducts from resource extraction and use, where waste and excess energy are the two main impact factors. At this stage economies usually find themselves lagging behind waste management from the low- and middle-income stages, where the advancement of waste management and treatment infrastructure typically have not been a core focus.

This difficulty to re-use waste as products or resources has arguably created a threshold that disincentivizes commercial players in the Norwegian market to innovate in this area, leaving access to disposal landfills as a safe and economically favorable option to the risky innovation investment that may lie in creating a new waste-to-product process. This prompts the wish for an answer to the following research questions of this thesis;

Research Question 1: *Is there a difference in economic profitability between companies with access to disposal landfills and those who do not?*

As we studied literature concerning financial performance, we also discovered that size is very commonly used as a control variable. Yet, we were of the opinion that size in itself was interesting to include anyhow. Thus, the second research question in our thesis is;

Research Question 2: *Do economies of scale lead to increased profitability in the waste management sector?*

4. Data

This chapter of the paper explains how the sample used in the later analysis was collected and selected. Further, the descriptive statistics and summarization are carried out.

4.1 Sample Selection and Criteria

The dataset consists of accounting data for 957 companies retrieved from the Brønnøysund Register Centre (BRC). This is raw data of high quality in terms of robustness as the numbers are reported directly from the companies themselves and follow strict reporting standards.

The companies label themselves with a segment category that should indicate the field they mainly operate within. Our experience from working with SAR is that these categorizations in many cases are unprecise. Especially when using this data for analysis, we wanted this to be as representative of the companies' activities as possible.

Therefore, we manually screened the companies, and re-categorized the companies that did not have a good fit with their current category. We did this based on the Standard Industrial Classification (SIC). As we mapped the entire industry during our internship at SAR, we were able to use that experience in the process of re-categorizing. The list we ended up with was also quality checked by SAR, to ensure that the categorization was as correct as possible. Overall, this process provides us with a more reliable sample.

The original sample consisted of companies that were considered not appropriate to include in the final data sample. The following criteria were the main reasoning for removing companies in the original data sample:

I. Farmers who are not operating in the waste management sector. They handle small portions of waste and thus happen to be in the dataset. These were considered irrelevant and therefore removed.

II. Car wreckers and scrap metal dealer. Even though they dispose and gather waste from cars, they were not considered relevant as waste managers and most of their operations concerns wholesale and retail of scrap metal.

III. Companies with inconsistent and missing accounting data for four years or more in our time period were left out. The main reason for this decision was the concern for inactivity.

IV. Holding companies were left out seeing that we only want operating companies in our sample.

V. Municipal and publicly owned companies were removed since we only want to look at the private sector.

The initial sample 957 companies are now down to 574 and consists of privately held companies which have their core-operations within the waste management sector.

4.2 Descriptive Summary of Waste Management Industry

Table 1 presents the different segments of the companies and shows the distribution of companies in each segment. For a deeper explanation of the segments, refer to Appendix 1.

Table 1: Descriptive Summary of the Initial Sample

		All		Landfills	
#	Segment	N	%	N	%
1	Collection of hazardous waste	25	4%	2	7%
2	Collection of non-hazardous waste	197	34%	12	43%
3	Treatment & disposal of hazardous waste	29	5%	7	25%
4	Treatment & disposal of non-hazardous waste	70	12%	5	18%
5	Offshore waste	9	2%	1	4%
6	Material recycling	40	7%	1	4%
7	Container rental	19	3%		
8	Electricity waste	12	2%		
9	Environmental consulting	3	1%		
10	Metal waste	99	17%		
11	Electricity production from biogas, incinaration & landfill gas	49	9%		
12	Environmental cleaning	22	4%		

Table 1 shows the number of companies for each segment. The count of firms in each segment is labelled N, while the percentage is their respective share relative to the total. It is clear to see that the companies represented in the hazardous waste segments are a minority as it counts only for 11 percent of the sample, this is including segment 1, 3 and 5. As discussed earlier in the thesis, we want to investigate whether landfills are linked to financial performance in the WM industry and if they have a positive impact on profit measures. Segment 7-12 are typically smaller companies, except for the metal waste segment which includes some large companies. To have a comparable sample for the analysis, the thesis will advance with segments 1-6 as these are the only segments where landfills are represented. This part of the industry is what we want to investigate.

Table 2 shows that the included firms have a higher turnover rate and size than excluded firms. These variables are related so the conclusion is that the included firms are on average bigger. Furthermore, most financial performance measures are higher for the included firms. However, the differences are only statistically different for SIZE and TURNOVER.

Table 2: Difference in Means Between Included and Excluded Firms

	Included firms (1)		**Excluded firms (2)**		**Difference (1-2)**
Variable	Mean	Std.	Mean	Std.	Diff.
EBITDA%	-0,08	0,06	-1,49	0,97	1,41
EBIT%	-0,16	0,06	-1,70	0,98	1,55
ROA	-0,10	0,08	-0,12	0,06	0,02
ROE	0,14	0,06	0,27	0,09	-0,13
TURNOVER	2,37	0,55	1,27	0,07	1,10**
SIZE	7,29	0,09	6,82	0,11	0,47***
LEVERAGE	1,78	0,59	1,69	0,62	0,09
CASH	0,21	0,01	0,21	0,01	0,00

Source: Accounting data retreived from Brønnøysundsregisteret (2014-2019).

*Note: Significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0,10$. EBITDA% and EBIT% are EBITDA- and EBIT margins, ROA is the return on assets, ROE is the return on equity. TURNOVER is the revenue/total assets, also called the turnover margin. SIZE is the logarithm of revenue. LEVERAGE is the debt/total assets. CASH is the cash & equivalents/total assets ratio. "Included firms" consist of the firms included in the further analysis while "Excluded firms" consist of the firms that were removed from the dataset. "Difference" indicates the mean of "Included firms" less the mean of "Excluded firms". Std. is the Standard Error.*

4.3 Descriptive Statistics of Landfill Segments

This section further investigates the variables included in the regression, with focus on the core segments. The exclusion of segment 7-12 resulted in a reduction of 204 companies in total. Thus, we have a final sample of 370 companies in segment 1-6. These companies have 28 landfills in total. The landfill data was retrieved from The Norwegian PRTR (NEA, 2021b).

Table 3: Presentation of Landfill Segments Presentation of Landfill Segments

		Observations		
#	**Segment**	**Firms**	**Landfills**	**Landfill concentration**
1	Collection of hazardous waste	150	12	7%
2	Collection of non-hazardous waste	1182	72	43%
3	Treatment & disposal of hazardous waste	174	42	25%
4	Treatment & disposal of non-hazardous waste	420	30	18%
5	Offshore waste	54	6	4%
6	Material recycling	240	6	4%

Source: Accounting data retreived from Brønnøysundsregisteret (2014-2019).

Note: Observations are the sum of observations of Firms and Landfills over 6 years. Landfill concentration is observations of landfills/observations of firms.

To get an overview of these variables, Table 4 is a summary of descriptive statistics. All the financial performance measures are negatively skewed, except from ROE, which is positively skewed. This can be explained by the extreme outliers in the dataset. The median will be a better indicator for the typical company in the industry. The SIZE variable is logarithmic to adjust for the variation in the firm revenues.

Table 4: Summary Statistics of all Variables (Segment 1-6)

Variable	Description	Formula	Mean	Median	Std.	Obs.
EBITDA%	EBITDA margin	EBITDA/revenue	-8,0%	7,6%	0,06	2 220
EBIT%	EBIT margin	EBIT/revenue	-15,5%	2,3%	0,06	2 220
ROA	Return on assets	Net income/total assets	-0,10	0,03	0,08	2 220
ROE	Return on equity	Net income/equity	0,14	0,08	0,06	2 220
TURNOVER	Asset turnover	Revenue/total assets	2,37	0,97	0,55	2 220
SIZE	Size proxy for company	Log of revenue	7,29	8,86	0,09	2 220
LEVERAGE	Debt to assets	Total debt/total assets	1,78	0,59	0,59	2 220
CASH	Cash to assets	Total cash & equivalents/total assets	0,21	0,10	0,01	2 220
LF	Landfill dummy variable	1 = landfill, 0 = no landfill	-	-	-	-

Source: Accounting data retreived from Brønnøysundsregisteret (2014-2019).

EBITDA% and EBIT% are EBITDA- and EBIT margins. ROA is the return on assets, ROE is the return on equity. TURNOVER return on assets, ROE is the return on equity. TURNOVER is the revenue/total assets turnover margin. SIZE is the logarithm of revenue. LEVERAGE is the debt/total assets. CASH is the cash & equivalents/total assets ratio. LF is a dummy variable, whereas the possession of landfills takes the value of 1, and non-possession takes the value of 0. "Landfills" includes the firms in possession of landfills (n=28), while "Ex. Landfills" includes the companies without landfills (n=342). "Difference" indicates the mean of "Landfills" less the mean of "Ex. Landfills".

The analysis of these six segments investigates whether firms with landfills are more profitable than firms without landfills. Thus, it makes sense to compare the differences in means between the two groups. As can be observed in Table 5, the financial performance measures EBITDA- and EBIT margins turned out significantly different between the two groups, as high as 25 percent and 22 percent respectively. The landfills seem to impact the earnings in a positive way, looking at the EBITDA and EBIT margins. However, TURNOVER is also significantly different, but the impact seem to be negative. Lastly, the firms with landfills seem to be of bigger size, as SIZE also came out highly significant. This signals that there might be economies of scale that impact the industry’s profitability as well. These variables will all be tested in the regression model in the Results chapter of the thesis.

Table 5: Difference in means - Landfills vs. Ex. Landfills

	Landfills (1)		**Ex. Landfills (2)**		**Difference (1-2)**
Variable	Mean	Std.	Mean	Std.	Diff.
EBITDA%	0,16	0,03	-0,10	0,07	0,25***
EBIT%	0,05	0,04	-0,17	0,07	0,22***
ROA	-0,08	0,13	-0,10	0,08	0,03
ROE	0,19	0,21	0,14	0,06	0,05
TURNOVER	1,07	0,06	2,48	0,60	-1,40***
SIZE	9,65	0,31	7,10	0,09	2,55***
LEVERAGE	0,88	0,21	1,85	0,64	-0,98
CASH	0,19	0,02	0,21	0,01	-0,02

Source: Accounting data retreived from Brønnøysundsregisteret (2014-2019).

*Note: Significance levels: *** p<0.01, ** p<0.05, * p<0,10. EBITDA% and EBIT% are EBITDA- and EBIT margins. ROA is the return on assets, ROE is the return on equity. TURNOVER is the revenue/total assets, also called the turnover margin.SIZE is the logarithm of revenue. LEVERAGE is the debt/total assets. CASH is the cash & equivalents/total assets ratio. "Landfills" includes the firms with access to landfills (n=28), while "Ex. Landfills" includes the companies without access to landfills (n=342). "Difference" indicates the mean of "Landfills" less the mean of "Ex. Landfills". Std. Is the Standard Error.*

At last, the correlation between variables included in the analysis is checked. Table 6 presents the correlation matrix between the time-varying variables in our sample. The correlation between LEVERAGE and TURNOVER variables is of a significant high value and thus, these variables should not be regressed simultaneously against the same dependent variable as this can cause multicollinearity. For this reason, TURNOVER is dropped in the regression. The ROA and DEBT variables have somewhat high negative correlation, despite this fact, we keep them in the regression, but are aware of the potential impacts between the variables. Other highly correlated variables are in between the dependent variables which indicates the regressions can be done with all variables except from TURNOVER.

Table 6: Correlation matrix

	ROA	*ROE*	*DEBT*	*Size Revenue*	*CASH*	*TURNOVER*	*EBITDA%*	*EBIT%*
ROA	1,00							
ROE	0,00	1,00						
DEBT	-0,35	0,00	1,00					
Size Revenue	0,07	0,05	0,00	1,00				
CASH	-0,09	0,05	0,05	0,10	1,00			
TURNOVER	-0,18	0,00	0,88	0,04	0,05	1,00		
EBITDA%	0,02	0,00	0,00	0,09	-0,01	0,00	1,00	
EBIT%	0,02	0,00	0,00	0,08	-0,01	0,00	0,99	1,00

Source: Accounting data retreived from Brønnøysundsregisteret (2014-2019).

5. Methodology

We use panel data regression to carry out the analysis, since the data is a combination of time-series and cross-sectional data. The dataset including the variables we want to test, is described in the previous chapter and since it involved firms across time, we would naturally have an unbalanced panel with missing data points across the period of interest. This is due to the fact that firms go bankrupt and are established or restructured over the years. The use of a statistical software that could handle the panel data without losing data was necessary to do the analysis.

There are several panel data regression models to choose between, but only a few will be relevant. When time-invariant variables of categorial nature like the landfill variable are included, the often used "Fixed Effects" (FE) model is inappropriate. The reason why the FE model will not make any sense in our case is that our dummy variables are consistent through the years and would therefore be removed in a FE model. On this basis, we used the "Random Effects" (RE) model for all our regression models.

Correlation was checked between the variables and the conclusion from the correlation matrix was to leave out TURNOVER, as it was highly correlated to LEVERAGE (Table 6). The reason being that we wanted to control for capital structure, rather than a financial performance measure. Robust standard errors are reported together with the estimated coefficients, as heteroskedasticity were detected in the data. (Breusch & Pagan, 1979).

5.1 – Regression model

The effect of landfill access and economies of scale on financial performance:

$$Y_t = \alpha + \beta_1 LF + \beta_z x_t + \varepsilon_t \tag{1}$$

Y is the dependent variable being regressed (EBITDA- and EBIT margins, ROA and ROE), x_t are the variables controlled for in the regression, and ε_t is the error term. The control variables are SIZE, CASH and LEVERAGE and are chosen based on previous research and the fact that size and capital structure affect firms' ability to generate profits significantly (Andersen & Dejoy, 2011). CASH is included because this is an industry where contracts are heavily practiced, whereas cash on the balance sheet can reflect bargaining power.

5.2 Control Variables

i. SIZE
ii. CASH
iii. LEVERAGE

A widely studied measure with impact on financial performance is size. There are several ways to measure size, whereas either assets or revenue are commonly used. In our thesis, we use the logarithm of revenue as a proxy for company size, this way we account for extreme outliers in the distribution of size, in addition to getting a normal distribution.

Debt-to-assets ratio (LEVERAGE) is also a common control variable to include when investigating financial performance in general as it can act as a proxy for risk. High debt-to-assets ratio make firms exposed to economic cycles. Cash is not the most studied control variable and is not as typical to include as size or debt. But cash-to-assets is an interesting ratio to include in an industry where it can represent bargaining power against competitors. This is the economic rationale behind the decision to include this variable. (Andersen & Dejoy, 2011).

6. Results

Chapter two in our paper investigated the generic waste generation, which is highly related to economic development. This has also been a focus area of previous studies and reports. Also, a big portion of waste is not being recycled, especially in the hazardous waste category. Given the fact that a substantial amount of waste is sent to landfill disposal facilities, made it interesting to investigate whether there are any economic incentives in terms of superior profit to dispose landfills and whether there are economies of scales affecting the profits as well.

Model: The effect of landfill access and economies of scale on financial performance

This model is investigating our main objective, and as Table 7 shows, access to landfills seems to be positively affecting the financial performance but does not come out statistically significant. This means it is not possible to conclude that landfill access increases profitability in the waste management sector in our model. However, the test gets a highly significant SIZE variable against EBITDA- and EBIT margin. This indicates that bigger companies – measured in revenue – have a positive effect on profitability within the WM industry. The low R-squared for the dependent variables indicate that a lot of the variance in the data is not picked up and explained by the model, and the goodness of fit is relatively bad. However, the models for EBITDA and EBIT are better.

Table 7: *Regression Output*

Independent Variables	(1) EBITDA%	(2) EBIT%	(3) ROE	(4) ROA
LF	0.127	0.118	0.071	0.157
	(0.247)	(0.255)	(0.231)	(0.288)
SIZE	0.060***	0.058***	0.012	0.004
	(0.015)	(0.016)	(0.014)	(0.018)
LEVERAGE	-0.0002	-0.0002	-0.0001	0.0003
	(0.002)	(0.002)	(0.002)	(0.003)
CASH	-0.212	-0.104	-0.210	-0.052
	(0.134)	(0.249)	(0.217)	(0.290)
Constant	-0.483***	-0.565***	0.092	-0.133
	(0.134)	(0.139)	(0.127)	(0.156)
Observations	2220	2220	2220	2220
R-squared	0.008	0.007	0.001	0.0002
Number of companies	370	370	370	370

Source: Accounting data retreived from Brønnøysundsregisteret (2014-2019).

*Note: Significance levels: *** p<0.01, ** p<0.05, * p<0,10. EBITDA% and EBIT% are EBITDA- and EBIT margins. ROA is the return on assets, ROE is the return on equity. SIZE is the logarithm of revenue. LEVERAGE is the debt/total assets. CASH is the cash & equivalents/total assets ratio. LF is a dummy variable, whereas the possession of landfills takes the value of 1, and non-possession takes the value of 0.*

The main indicator for financial performance in our analysis is company size, which was highly significant in the earnings measures. Several conditions could explain this. Larger firms usually have a wider range of operations working together, and benefits from a scaling economy. In addition to this, the size of the firm usually takes time to build, and with time comes experience and reputation. These are snowball effects that can help firms gain margins that smaller firms can’t. Recent years have been fierce in terms of competition in the WM industry and more capital intense firms have an advantage over smaller firms related to gaining profits for reasons mentioned above. Further, the advantage of economies of scale is the market power it represents. These might be some indicators pointing in the direction of size being a determinant of financial performance in the WM industry.

7. Conclusion

The waste management industry is complex, and therefore, it makes sense to look deeper into fractions of the industry. This thesis investigates the evolution of waste in Norway which provides valuable insight into the current situation. In addition, we investigate financial performance in relation to landfills and economies of scale in the industry.

The thesis highlights the problem related to the high share of waste ending up at landfills, which is not only economically inefficient but also harmful for the environment. Thus, we tested whether there were economic incentives related to possessing disposal landfills. Potentially, this could explain some of the reason why more waste has ended up at landfills over the recent years.

We find a significant difference in profitability between companies with access to landfills and those without. However, when analyzing the model including control variables, the difference seems to diminish. Consequently, these results are somewhat of a contradictive nature. This makes it hard to draw any final conclusions to research question 1. This may be a consequence of the rather small data sample of landfills.

On the contrary, economies of scale had a strong impact on the profitability in the industry. This result may be explained by the advantage of having more market and negotiation power against competitors in the industry, as this is a contract-based industry, in which negotiation power can be a crucial intangible asset. Therefore, we can conclude that the answer to research question 2 is that economies of scale, does in fact positively impact profitability.

The waste management industry in Norway has not been studied enough in areas outside the municipal waste sector. Our findings add insight to the literature as the landfill subject is a scarce one and we encourage further research within this field.

Our findings encourage further studies of the waste management industry. There are vast possibilities for utilizing the datasets of NEA to analyze different waste fractions and their impact on profitability. Also, we encourage for further studies on how waste is related to circularity and sustainable growth.

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Appendix 1: Standard Industrial Classification (SIC)

D – Electricity, gas, steam and air conditioning supply

35000 - Electricity, gas, steam and air conditioning supply

Includes delivery of electricity, natural gas, steam, hot water through pipes. Also includes delivery of steam and air conditioning.

- 35100 – Electric power generation, transmission and distribution

  Generation of electricity in bulk, transportation from production facilities to the distribution network and distribution to end users

  - 35110 – Production of electricity

    Relates to facilities producing electrical power including thermal power, atom power, hydropower, gas turbines, diesel facilities and renewable energy

    - 35113 – Distribution of electricity (Remove?)

E – Water supply; sewerage, waste management and remediation activities

Activities related to handling (including collection, treatment, neutralizing and removing) of different types of waste e.g. solid and non-solid industrial and household waste, in addition to contaminated soil.

38000 – Waste collection, treatment and disposal activities, materials recovery

Includes collection, treatment and transport of waste material and the operation of material recovery facilities.

- 38100 – Waste collection

  Related to waste collection from households and businesses using different types of waste containers, collection of non-hazardous and hazardous waste, e.g. household waste, used batteries, used consumable oils and fats, waste oil (spill olje) from ships, cars and waste from construction sites.

  - 38110 – Collection of non-hazardous waste

    Includes collection of non-hazardous waste from local areas, e.g. households and businesses in different types of waste containters, mixed recovery materials and public waste containers

  - 38120 – Collection of hazardous waste

Includes collection of solid and non-solid hazardous waste, i.e. waste including explosives, combustible, oxidizable, toxic, irritating, carcinogenic substance, corrective agents, infectious agents or other health- and environmental harming substances. Collection of waste oil from ships, car workshops, hazardous organic waste, radioactive waste, used batteries and hazardous waste for storage. Also includes activities related to transportation packaging.

- 38200 – Waste treatment and disposal

  Includes various treatments; organic and other polluting waste, used goods like refrigerators with the goal of eliminating harmful waste, removal of waste by destruction or incineration, including energy recovery. Treatment and removal of easily biodegradable radioactive waste from hospitals, dumping of waste onshore as well as offshore.

  - 38210 – Treatment and disposal of non-hazardous waste

    Includes pre-disposal, disposal and final disposal of non-hazardous waste (solid and non-solid): Operation of waste disposal sites, final disposal of non-hazardous waste by incineration or destruction or other methods with or without production of electricity or district heating, production of alternative energy sources like biogas, disposal of ash or other bi-products.

  - 38220 – Treatment and disposal of hazardous waste

    Includes pre-disposal, disposal and final disposal of solid and non-solid hazardous waste, i.e. waste including explosives, combustible, oxidizable, toxic, irritating, carcinogenic substance, corrective agents, infectious agents or other health- and environmental harming substances. Operation of disposal sites for hazardous waste treatment, destruction and elimination of hazardous waste including treatment and encapsulation of radioactive waste.

- 38300 – Materials recovery

  - 38310 – Dismantling of wrecks

    Includes materials recovery by dismantling of vehicles, ships, machines, computers and televisions.

  - 38320 – Recovering sorted materials

    Includes processing of metallic and non-metallic waste, scrap and other secondary raw material objects. The following mechanical and chemical transformation processes are used: sorting of paperfractions, mechanical wrecking of metal waste from used vehicles, washing machines. Other waste types include waste from food and consumable sources for secondary raw material recovery.

39000 – Remediation activities and other waste management services

Includes cleansing of polluted constructions and sites, soil, surface water and groundwater

G – Wholesale and retail trade; repair of motor vehicles and motorcycles

Includes wholesale and retail trades with all types of goods and services (new and used). Requires the sale to be of non-processed art.

46000 – Wholesale trade, except of motor vehicles and motorcycles

Includes businesses which operates within resale of new and used goods to other business operating entities – industrial firms, resellers, farmers, construction activities amongst others.

- 46700 – Other specialized wholesale

  Includes specialized product ranges in other industry groups, included semi-finished products.

  - 46770 – wholesale of waste and scrap

Includes metallic and non-metallic waste and materials for reusage, included collecting, sorting, separation, removal of surface layers in relation to used goods, e.g., vehicles. Packaging and re-packaging without transforming the product.