Analysing and comparing sustainability strategies from an economically profitability perspective

From the cities Amsterdam, London, and Singapore

university of groningen

Colophon

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Abstract

In this research, the sustainability strategies of the cities Amsterdam, London and Singapore are analysed and compared from an economically profitable perspective and lessons are drawn from each strategy. This is done by using the research question: What are sustainability strategies from an economically profitable perspective from the cities Amsterdam, London and Singapore and how do they compare with each other and which general lessons could be drawn from each strategy for future sustainability strategies? The chosen research method is a qualitative research in which sustainability strategies from the three concerned cities are used. The strategies are the data in this research. The strategies will be analysed based on their content, implementation, environmental benefits and economic costs and benefits. The strategies from London and Amsterdam have similar environmental benefits, while Singapore's strategy has lower environmental benefits as well as economic benefits. Amsterdam's strategy has the highest economic benefits as these benefits are not only beneficial for the city, but for Europe and the discussed value chains. London's economic benefits will only be noticed on the very long term, but will be high as well. The innovativeness is going well in each strategy which will increase both the environmental and economic benefits. The lessons drawn from the strategies all regard consumer behaviour and improvements should be make on this topic.

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1. Introduction

As cities are a large source for pollution and waste, strategies for integrating sustainability in the urban planning has become essential (Klopp & Petretta, 2017). Approaches and actions included in the strategies are identified by local planners (Liang et al., 2020). This means that every city has a different strategy on making the city more sustainable. Strategies must operate successfully in different aspects. They have to succeed simultaneously in an environmental, economic, and social aspects (Shmelev & Shmeleva, 2019). The economic aspect of the strategies will be the focus of this bachelor thesis. Environmental problems, like climate change and degradation of natural sources, have unfavourable consequences on the human population. These problems are solved through sustainability development and it was thought for a long time that these solutions had a positive effect on the economic environment (Borza, 2014). However, Borza (2014) concludes that this is not the case. Instead, by focussing on the economic sustainability and on the production and dematerialised services, the efficiency of resource use, like energy, will increase. This results in a long-term, global, sustainable economic growth (Borza, 2014). With this economic growth, new technology could be introduced for more sustainable innovations and processes to increase sustainability further. Furthermore, Ruth et al. (2015) argue that when energy efficiency is increased, it extends the policy space for reducing emissions and it reduces vulnerability to climate change.

The economic aspect is often not discussed in strategies while this would lead to an increase in sustainability and economic growth. It is a challenge to balance improving sustainability and achieve economic growth (Saint Akadiri et al., 2019). It is therefore crucial for cities to have knowledge about sustainability strategies from an economic perspective for this challenge to be reduced. This bachelor thesis aims to discuss and solve this knowledge gap by evaluating and comparing different strategies of different cities, from an economic perspective. Thereby, lessons can be drawn from the different strategies.

1.2. Research problem

The aim of this research is to analyse and compare sustainability strategies of Amsterdam, London and Singapore on sustainability and economically profitability and conclude how other cities can implement these strategies into their own urban planning. This is done by using the research question:

What are sustainability strategies from an economically profitable perspective from the cities Amsterdam, London and Singapore and how do they compare with each other and which general lessons can be drawn from each strategy for future sustainability strategies?

To answer this research question, several questions need to be answered first.

1. What are the sustainability strategies, from an economically profitability perspective, from each city?
2. How is each strategy economically profitable and sustainable?
3. How do the strategies compare to each other?
4. Which lessons can be drawn from each strategy that can be used for future strategies?

1.3. Structure

In the following section, the theoretical framework is presented. Here, the concepts that are relevant to this thesis will be explained. Furthermore, the conceptual model and hypothesis are presented. Then, the methodology is presented in which the choice of research method is described and how the data is collected. Afterwards, the results of the research follow. Here, the content, implementation, environmental benefits and economic costs and benefits are described. Having the results, the three strategies will be compared to each other and lessons, drawn from each strategy, will be presented. In the conclusion, the main points of the research and the drawn lessons will be summarised. Then, a reflection is given on what is going well in each strategy and what can be improved. Lastly, the strengths and weaknesses of this research will be reflected on and recommendations for further research are made.

2. Theoretical framework

Focussing on both sustainability and economical profitability is called economic sustainability (Saint Akadiri et al., 2019). Economic sustainability includes reducing environmental degradation and achieving economic growth (Saint Akadiri et al., 2019). By analysing the environmental benefits and the economic costs and benefits of each strategy, more insight is attained about the economic aspect of sustainability strategies from which lessons can be drawn.

2.1. Defining concepts

Several economic sustainability key concepts are innovativeness, competitiveness, efficiency and consumer behaviour (Ruth et al., 2015; Shukla and Iyengar, 2013; Spangenberg, 2005). Innovativeness is the ability to create new innovations (Nasierowski and Arcelus, 2012). According to Sajeva et al. (2005), an innovation is ““the process leading to the adoption and diffusion of new technologies, aimed at creating new processes, products and services”. Competitiveness is managing every quality that a nation or company has to achieve prosperity or profit (Bhawsar and Chattopadhyay, 2015). When one is innovative, it can be competitive (Nasierowski and Arcelus, 2012). According to Borza (2014) efficiency is “the most appropriate form of expressing the extent to which the available production factors of a nation are capitalized”. Consumer behaviour is the pattern in which consumers purchase goods (Shukla and Iyengar, 2013).

After reviewing the literature, several more concepts and theories have been selected that are used in the sustainability strategies and are relevant for this research. These concepts are Circular Economy, PM10, Ultra-Low- and Low Emission Zones and green energy. Circular Economy is a closed-loop material cycle in which the use of raw materials is decreased and preventing waste by sustaining the value of products as long as possible. The resources will be used as many times as possible through recycling (Joensuu et al., 2020). In the sustainability strategy of Amsterdam, Amsterdam Circulair (Circular) 2020-2025, the concept of Circular Economy is defined as “high quality processing materials and raw materials which results in closing material loops and avoid them becoming waste” (Gemeente Amsterdam, 2020a, p.5)

PM10 is an abbreviation for Particular Matter 10. 10 is the diameter of the matter in micrometre. This particular matter can enter the body by breathing and can penetrate until the upper respiratory tract (RIVM, 2021).

Another relevant concept is the concept of Low Emission Zones (LEZ). LEZ are zones in a city that allow only a little amount of emission coming from vehicles. In the Ultra-Low Emission Zone (ULEZ) only electric vehicles and hybrid electric vehicles that are on the electric mode, are allowed to enter (Biswas et al., 2019).

Green energy is renewable energy. With renewable energy, electricity is produced from sources like solar, wind, geothermal, biogas, and biomass (Arroyo and Carrete, 2019).

2.2. Conceptual model

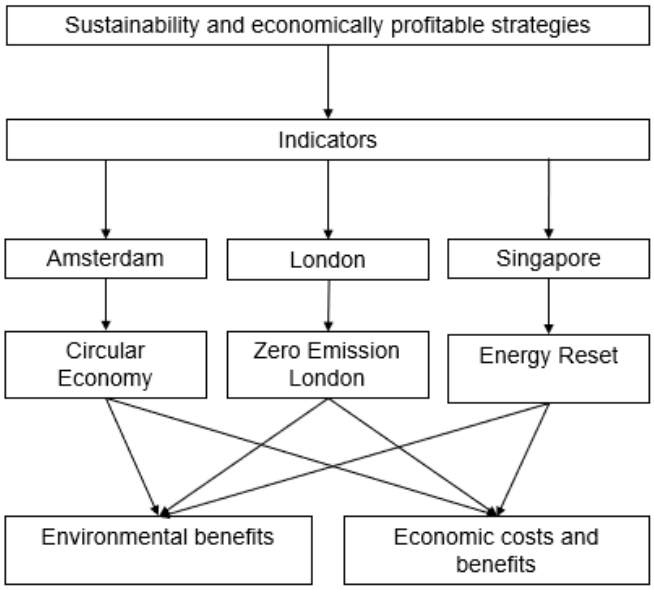

Figure 1. Conceptual model

2.3. Hypothesis

Based on the framework with indicators it is expected that innovativeness and efficiency are important topics in the concerned strategies and are important for both the environmental benefits and economic costs and benefits. Additionally, it is expected that the focus is less on consumer behaviour as the indicators in the framework show that the strategies focus on many topics in which consumer behaviour is not of interest.

3. Methodology

3.1. Research method

The chosen research method for this bachelor thesis is a qualitative research in which sustainability strategies from the three different cities are analysed and compared to each other. In this analysis, the strategies will be evaluated on their sustainability from an

economically profitable perspective. This means that the chosen strategies are expected to be both sustainable and economically profitable.

3.2. Data selection

The dataset exists of the strategies provided by the municipalities of the three different cities: Amsterdam, London and Singapore. These cities are chosen because all three cities are economically strong, which means that they have the assets to finance an extensive strategy (Gemeente Amsterdam, 2011; Huat, 2003; Mayor of London, 2018a). Furthermore, to keep the dataset diverse, the chosen cities are not all on the same continent.

For Amsterdam, the strategy is provided by the municipality of Amsterdam in the strategy of Amsterdam Circulair 2020-2025. For London, the strategies are provided by the Mayor of London, with the Environment strategy. The strategy is provided on the website of the Mayor of London instead of in one document. Furthermore, the executive summary by the Mayor of London is used as well. For Singapore, the strategy is provided by the Singapore Government Agency. This strategy is called the Green Plan and is provided on the website. This data is considered the main data. Secondary data is used for determine the environmental benefits and the economic costs and benefits of each strategy.

The quality of this data is expected to be high as the strategies are provided by the municipality of the city. This means that the strategies are directly from the concerned city itself. Articles are used for analysing the strategies. By doing this, the costs and benefits are provided by an independent source and are represented from multiple views.

3.3. Data analysis

For the data analysis, a framework has been established with indicators, based on the key concepts of economic sustainability and the content, the motivation and the implementation of the strategies. Of each indicator it is indicated whether it is included in the strategy of each city. After analysing this framework, the strategies can be compared to each other and lessons can be drawn. The framework is shown in appendix 1.

3.4. Data analysis scheme

Below, the data analysis scheme is presented on which steps will be taken and in which order when analysing the strategies.

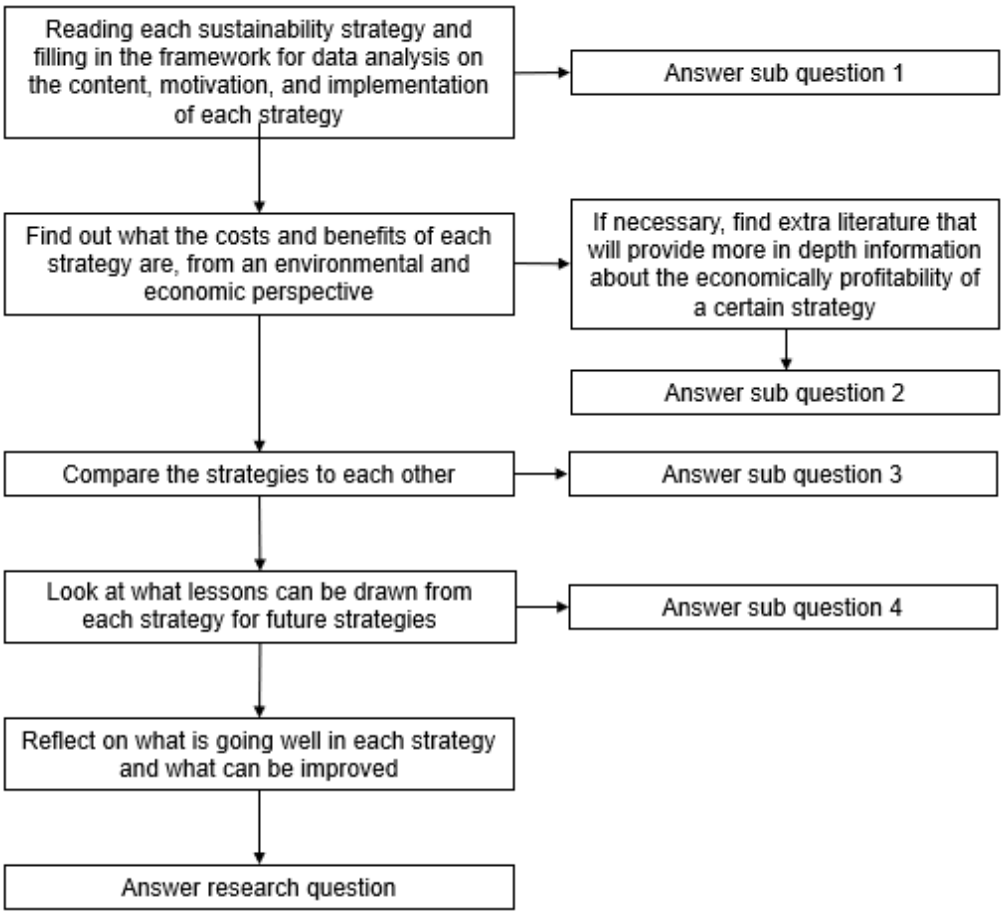

Figure 2. Data analysis scheme

3.5. Ethical consideration

As this is a literature-based research, there are no ethical considerations. One consideration is to be adaptable. The actual outcome of this research could differ from the expected outcome. Should this situation present itself, it is important to adapt and deviate from the expected outcome. Furthermore, it is important to reference correctly to prevent fraud.

4. Results

The framework with indicators can be seen in appendix 2.

- *What are the sustainability strategies, from an economically profitability perspective, from each city?*
- *How is each strategy economically profitable and sustainable?*

4.1. Amsterdam

4.1.1. Content

The strategy from Amsterdam is called ‘Amsterdam Circulair 2020-2025’. Its goal is to have 50% less raw materials in 2030 and to be 100% circular in 2050. The municipality of Amsterdam (2020a) argues that with this strategy, the value of products will be preserved,

there will be less waste in the city, more employment opportunities will be created, and it will create a rich biodiversity in the city. They mostly focus on three value chains: the food and organic residual streams, consumption goods, and the built environment. The value chain food and organic residual streams is chosen because the food supply has a large ecological impact. It mainly includes the reduction of food waste, both in household and catering industry. This could be done by, for example, recycling organics. Frying oil can be used as biodiesel for city busses or in refineries as a replace for plastic. When looking at these ideas it becomes clear that innovativeness is an important part of this strategy. Furthermore, they strive for a higher consumption of regional produced and vegan food. Focussing on this value chain creates a rich biodiversity in the city as waste can act as compost or houses for insects (Gemeente Amsterdam, 2020a). The second value chain, consumption goods, contribute to the depletion of scarce raw materials and because producing consumption goods is often polluting and are produced under poor working conditions. The main focus of this value chain, therefore, lies on consumer behaviour with reducing the use of electronics, textile, furniture and focus on the efficiency of processing the residual streams. Also, materials can be repaired by specialists (Gemeente Amsterdam, 2020a). The third value chain, the built environment, is chosen as the built environment has to connect with the continuously changing needs and thus Amsterdam has to construct in the strategy of Circular Economy. This is done through the municipality deciding on how to use the public space and what is built where. Furthermore, using sustainable material to build with, giving materials multiple functions and planning the city climate adaptive could be ways to have the built environment within the strategy of Circular Economy (Gemeente Amsterdam, 2020a).

4.1.2. Implementation

The municipality of Amsterdam has several plans and policy instruments to implement this strategy. In 2019, subsidies were granted to companies for circular initiatives. Furthermore, the regulations for granting subsidies were changed, which made it possible for cultural institutions to request a subsidy. This would stimulate the cultural sector to become more sustainable. Moreover, with the INTERREG-subsidy coming from the European Union, the collaboration between stakeholders in the region of Amsterdam and European partner regions would be reinforced (Gemeente Amsterdam, 2020b). Another policy instrument would be to change the land rates and levies in order to have control over the design and construction of buildings and the public space. Hence this instrument would be used in the value chain of built environment. Also, physical changes will be made to the urban planning, like building places for waste collection and for the reuse of this waste and so closing the material loop (Gemeente Amsterdam, 2020a). Raising awareness is important for the value chains of food and organic residual streams and consumption goods. With the help of campaigns, the residents will be made aware to separate waste, to the value of their products, and work together with processing companies (Gemeente Amsterdam, 2020a). This means that the municipality also stimulates the collaboration between innovative partners and companies to develop better product and they focus on the competitiveness of the partners and companies, which is important in the value chain of consumption goods. Additionally, the legislation has to be regularly sharpened in order to keep up with the developments and thus keep stimulating the companies that are frontrunners in adapting to Circular Economy (Gemeente Amsterdam, 2020a). For all this to work, the municipality will act as example and be the first to adapt to the strategy of Circular Economy.

4.1.3. Environmental benefits

It has been estimated that Circular Economy will result in a reduction of emissions of 48% by 2030 and 83% by 2050, compared to 2012 (Ellen MacArthur Foundation et al., 2015). This reduction will be in the value chains mobility, food and built environment. As Amsterdam will focus on food and built environment, it is expected that there will be a reduction in emissions, but as the strategy included two of the three value chains, this reduction will be lower. However, this will be compensated by the value chain 'consumption goods'. This value chain will have environmental benefits as well as there will be positive correlation between the ecological footprint and the consumption of goods (Hajilou et al., 2014). This means that when the consumption is reduced, the ecological footprint will be reduced as well. Food waste reduction, regenerative and healthy food chains, passive houses, urban planning and renewable energy would be the sources of emission reduction across the value chains of food and built environment (Ellen MacArthur Foundation et al., 2015). Furthermore, it will lead to the reduction of the loss of resources and ease the burden on ecosystems (EEA, 2016).

4.1.4. Economic costs and benefits

According to Huang et al. (2021) the strategy of Circular Economy has high economic costs and low economic benefits on the short term. The transition to a Circular Economy requires changes in many value chains. The municipality of Amsterdam will only focus on three value chains. However, in the value chain of consumption goods, costs will be made relating to all consumption goods. In addition, costs will be made by companies regarding collaborating with other companies (Huang et al., 2021). This is more difficult for small to medium sized companies (Rizos et al., 2016). However, according to the Ellen MacArthur Foundation (2015), the net material cost savings will be as high as $630 billion annually for the complex products industry, especially for products like motor vehicles and machinery. The net material savings in the consumer goods sector is expected to exceed $700 billion annually on a global level. As the municipality of Amsterdam is planning on granting subsidies for companies for circular initiatives, it will grow Europe's resource productivity by 3% by 2030, which is around €1.8 trillion total benefits in the three areas of mobility, food, and the built environment (Rizos et al., 2016). This means that Amsterdam will benefit from this as two out of the three value chains, that are being focussed on, are food and the built environment. Besides having economic benefits, Circular Economy will also result in an increase in job opportunities. In the UK, it is estimated that Circular Economy in recycling and remanufacturing, at which Amsterdam is focussing as well, will create 54,000 jobs by 2030 (Mitchell and Morgan, 2015). Thus, on the short term, the economic costs will be lot higher than the economic benefits. However, on the long term, the economic benefits will be higher than the economic costs.

4.2. London

4.2.1. Content

The strategy from London is called 'Zero Emission London'. The goal of this strategy is to have the best air quality of any major city by 2050. This strategy is implemented as toxic air pollution is still the biggest environmental risk to the health of city residents and reducing the amount of pollution from traffic remains one of the best way of cleaning up the air (Mayor of London, 2021a). The strategy contains different zones in the city for which drivers will be charged when not meeting the standards for that zone. The Ultra-Low Emission Zone (ULEZ) operates in Central London every day, and vehicles need to meet the standards in order to enter the zone

without a charge. Only electric vehicles and hybrid vehicles are allowed to enter the zone free of charge. Starting 25 October 2021, the ULEZ will expand to the North Circular Road and the South Circular Road, without including the roads itself (Mayor of London, 2021a). The LEZ covers most of Greater London and operates every day. Heavy diesel vehicles must pay a charge to enter this zone. However, from 1 March 2021, the standards for this zone, inside the Circular Roads, will change to match the ULEZ. This means that this LEZ will turn into an ULEZ (Mayor of London, 2021a). The Congestion Charge Zone (C-charge) operates in Central London and for almost all vehicles that drive within the zone between 7am and 10pm every day, except Christmas Day (25 December) (Mayor of London, 2021a). There are also zones for construction machinery as the construction is a significant contributor to London's air pollution (Mayor of London, 2021b), the LEZ for Non-Road Mobile Machinery . Every zone and the corresponding daily charges are found in appendix 4.

Figure 3. The LEZ and the ULEZ how it is today. Red = ULEZ, green = LEZ (Transport For London, 2021)

4.2.2. Implementation

In order to implement this strategy, the Mayor of London has implemented charges, with every zone having different charges. When expanding the ULEZ into the LEZ, the standards of that zone are changed and thus the charges will also change to fit the ULEZ (Mayor of London, 2021a). By charging vehicles that enter a zone, awareness is raised among the drivers and cleaner vehicles are purchased more often when purchasing a new vehicle (Ye et al., 2021), so drivers can enter the zone without paying the charge. This means that consumer behaviour changes and demand will increase. With this increase, the supply has to increase as well, according to the supply and demand theory, and there will be more room for new innovations and technology regarding electric vehicles. More electric vehicles will result in a reduction of CO2 emissions (Ye et al., 2021). Furthermore, more information will be provided to the Londoners on air pollution and when it is bad for their health. Also, guidance will be provided and citizens with fireplaces will be informed on which fuels to use that result in less air pollution

(Mayor of London, 2018). No subsidies will be granted for individuals and companies to purchase cleaner vehicles or machinery (Mayor of London, 2021a). Charging and refuelling infrastructure will be constructed to support the electric vehicles (Mayor of London, 2021a).

4.2.3. Environmental benefits

The ULEZ will be expanded as the air quality in the ULEZ has largely improved, with toxic NO2 concentrations being reduced by 44 percent and a reduction of 97 percent of state primary and secondary schools that are located in areas that exceed the legal limits for NO2 (Mayor of London, 2021a). Furthermore, the percentage of children living in areas that exceed the legal limits for NO2 has decreased from 99% in 2009 to 34% in 2013 (Mudway et al., 2019). This means that NO2 emissions has decreased as well. According to Dajnak et al. (2017), the scenario of implementing the ULEZ would result in a reduction of 56% in NO2 emissions in 2025 compared to 2020. The LEZ has saved around 12,300 tonnes of CO2 emissions (Mayor of London, 2021a). However, in the first five months after implementing LEZs, a 13.1% increase of PM10 was recorded along major roadways towards London. This increase was a result of behavioural adjustments. Drivers detoured around the LEZ to avoid the charge (Zhai and Wolff, 2021). After these five months, PM10 reduced with 5.5% along London roadways (Zhai and Wolff, 2021).

4.2.4. Economic costs and benefits

Compared to 2020, as a result of the reduction of NO2 emissions, the life expectancy of male Londoners, born in 2025, is predicted to increase by 1.7 months and for female Londoners, it is predicted to be 1.5 months (Dajnak et al., 2017). Because of this increase in life expectancy, the population of Greater London will gain 1.4 million life years in total. As a result, the estimated economic benefit of NO2 improvements, compared to 2020, will be up to £800 million (at 2014 prices) (Dajnak et al., 2017). The charges for entering the zones can be seen as an economic benefit as well as this money is going to the municipality of London (Mayor of London, 2018b). The costs of the charging stations and refueling infrastructure are not mentioned by the Mayor of London. According to Xiangang Tang et al. (2011), the costs of charging stations depend on the capacity of a charging station, in megawatt (MW); the higher the capacity, the higher the costs. These costs are the initial investment costs, the land acquisition costs and the annual operating costs (Xiangang Tang et al., 2011). The costs can be found in appendix 5.

4.3. Singapore

4.3.1. Content

The strategy from Singapore is called ‘Energy Reset’. This strategy is part of the Singapore Green Plan 2030 and the goal of this strategy is to lower Singapore’s carbon footprint which is done through the use of cleaner energy and increasing the energy efficiency (Singapore Government, 2021). By using innovative products and services to achieve this, their competitive position will be enhanced, as the ease of doing business is an important quality of Singapore (Aliedan, 2020). It consists of three programmes. The first programme is the housing programme, ‘HDB Green Towns Programme’. This programme is for reducing the annual energy consumption in HDB (Housing & Development Board) towns by implementing innovative alternatives and solutions. HDB towns are neighbourhoods with social housing and under the authority of the Housing & Development Board, which is Singapore’s public housing

authority (Housing & Development Board, 2021). Since 2005, the aim is to reduce the annual energy consumption by 10% and by a further 15% by 2030 (Ministry of National Development, 2021). The strategy has four key initiatives (Ministry of National Development, 2021):

1. Reducing energy consumption with solar panels and smart LED lighting.
2. Piloting water harvesting systems to recycle rainwater and mitigate flood risks. The collected rainwater can be used for washing of the void decks and water of plants.
3. Piloting new ways to cool the HDB towns, for example by using cool paint which can reduce the ambient temperature by up to 2 degrees.
4. Injecting rooftop greenery, community farming and urban farms at more multi-storey carparks. This increases green cover and provides more green spaces for residents to enjoy.

The second programme is the building programme ’80-80-80 in 2030’ (Singapore Government, 2021). The goal of this programme is to change the energy source of 80% of Singapore’s buildings to green energy, based on its gross floor area, by 2030. Moreover, to construct 80% of new buildings, based on its gross floor area, to be SLE (Super Low Energy) buildings from 2030. And last, to have an 80% improvement, compared to 2005, in energy efficiency by 2030. This improvement is for the buildings that already use green energy.

The third programme is the transport programme with its goal to phase out internal combustion engine vehicles and have all vehicles run on cleaner energy (Singapore Government, 2021). Its 2025 target is to discontinue new registrations of diesel cars and taxis from 2025 and to have eight HDB towns ready for electric vehicles by having chargers at carparks by 2025. Its 2030 target is to have all new car and taxi registrations to be of cleaner-energy models from 2030 and to have 60.000 charging point for electric vehicles by 2030, with 40.000 in public carparks and 20.000 in private premises.

4.3.2. Implementation

The government of Singapore will make physical changes to the urban planning when implementing this strategy with constructing rainwater collection infrastructure, using cool paint to paint the outside of houses, installing solar panels, constructing electric vehicle charging points and implementing rooftop greenery and urban farms. Furthermore, new regulations will be implemented. This is done in the transport programme, where diesel cars and taxis will not be able to register anymore from 2025. From 2030, all registrations have to be of cleaner-energy models. The government of Singapore does not grant subsidies for any form of energy (Jindal et al., 2021). This means that companies and individuals will not be granted subsidies for transitioning to green energy.

4.3.3. Environmental benefits

Investing in green energy results in a reduction in greenhouse gasses and it improves the energy efficiency by improving the total factor carbon productivity (Sarkodie et al., 2021). According to Qiu et al. (2021) adopting solar energy, a form of green energy, results in a reduction of electricity delivered from the grid infrastructure. Most reduction occurs during the day when solar radiation is mostly present. Furthermore, after installing solar panels, consumers pay less for the electricity bills. This means that electricity is considered cheaper. Because of this, consumers increase their electricity consumption. In the evening, the

electricity is purchased from the grid again and an increase is seen in the electricity consumption as well. From this, it can be concluded that the energy demand increases because of the installation of solar panels (Qiu et al., 2021). 95% of Singapore's energy source is natural gas (U.S. Energy Information Administration, 2016). When natural gas is replaced by solar energy, the CO2 emission will be reduced by 28.04% (Noorollahi et al., 2021). However, because of the increase in electricity demand, the reduction of emission will most likely be smaller than first anticipated as natural gas emits CO2 (Naeem et al., 2021). By painting with cool paint, the ambient temperature decreases by 2 degrees (Ministry of National Development, 2021). This means that the residents do not have to cool it using air conditioning and thus in this aspect, the electricity demand decreases. The demand decreases as well when increasing the energy efficiency. With this method, energy is saved and around 84,801 tons of CO2, globally, can be saved during the lifetime of buildings that have done this (Aste et al., 2016).

4.3.4. Economic costs and benefits

When more companies and individuals install solar panels, the energy demand increases. This means that the investment in grid infrastructure remains the same, while the electricity sales decrease as this energy is replaced with solar energy (Qiu et al., 2021). This means that the investments in grid infrastructure will cost relatively more. The annual economic benefit of reduced air emissions from the use of an average-sized solar panel system is $1147 (in 2018 U.S. dollars) (Qiu et al., 2021). When this is calculated over the lifetime of the panel system, assuming a 30-year lifetime, this economic benefit is $22,474 (Qiu et al., 2021). Furthermore, according to Noorollahi et al. (2021) the total energy cost can be reduced by 26.73% when solar energy is used instead of natural gas. When the energy efficiency is increased in a building, extra costs are made. However, the building will save a lot of energy and thus, in return, the electricity costs will be reduced (Aste et al., 2016).

The costs and benefits of electric vehicles and its charging points are mentioned underneath the strategy of London.

5. Comparison

How do the strategies compare to each other?

5.1. Environmental benefits

Singapore's 'Energy Reset' has the least environmental benefits when taking the environmental benefits from every strategy in consideration. Green energy and solar energy will reduce CO2 emissions and greenhouse gasses. However, as the energy demand increases, an increasing amount of energy is also used from the grid infrastructure when the energy switches back to the grid, which in this case is natural gas which emits CO2 emissions. The energy demand decreases through energy efficiency and cool paint and thus the CO2 emission. The environmental benefits from Amsterdam and London are similar. Amsterdam will experience a reduction of emissions of 48% in 2030 and 83% by 2050. For London, NO2 emissions will be reduced by 56% by 2025. As London had already started with implementing its strategy and Amsterdam has not, it is expected that London will already notice results in 2025 and Amsterdam only in 2030. Furthermore, London will experience a reduction of PM10 as well and has already saved around 12,300 tonnes of CO2 emissions. Some differences to

take into consideration are that London has already implemented LEZs around 2009, while Amsterdam still has to implement its strategy. Furthermore, London's strategy focusses on the direct emissions from vehicles, while Amsterdam focusses on the emissions from the processes in the value chain. The reduction of emissions is a result of three value chains, while London only focusses on one aspect, which is transport. In addition, Amsterdam has to rely on the behaviour of its residents and companies, while London forces its residents to change their behaviour. Because of this dependence of Amsterdam, the reduction of emissions could possibly disappoint.

5.2. Economic costs and benefits

Singapore's 'Energy Reset' has the least number of economic benefits and Amsterdam's 'Amsterdam Circulair 2020-2025' harbours the most economic benefits when looking at the economic costs and benefits of each strategy. As the energy demand increases in Singapore after installing solar systems, the investment in grid infrastructure remains the same, while the electricity sales decrease. This means that the investments in grid infrastructure will cost relatively more. The economic benefit of an average-sized panel system is $22,474 over its entire lifetime. Adopting solar energy can reduce the total energy costs by 26.73% and the electricity costs will be reduced when buildings become energy efficient. That is relatively low when comparing this to the benefits of the other strategies. The economic benefits of Amsterdam's strategy are not just for the city, but for entire value chains and the EU economy. The benefits are reaching hundred billions of dollars and the resource productivity will be increased. The benefits for Amsterdam will be part of these benefits. However, these are calculated for the entire value chains, so the actual benefits for Amsterdam are expected to be lower. There will be job opportunities created in Amsterdam as a result of this strategy. Although the costs relating to the value chain of consumption goods will be very high on the short term, the benefits will be high on the long term. The economic benefits of London's strategy are local. These costs are for the city of London only. As a result of an increase in life expectancy, the benefits will be up to £800 million (at 2014 prices). These benefits will be noticed on the very long term and will not be noticed in a couple of years. The costs for constructing charging stations are high and annual costs are made, to keep them running. So, the costs on the short term will be high. In the long term, the costs will be decrease and even further in the future, the economic benefits will be higher than the costs.

5.3. Implementation

Appendix 2 shows that Amsterdam has taken most measures to implement the strategy, after that London, and finally Singapore. Two measures that all three cities have focused on is making physical changes to the urban planning and implementing new standards, laws and/or regulations and fees. By changing the urban planning, buildings can be constructed to accommodate new initiatives and by implementing new standards, law and/or regulations and fees, residents and companies are forced to adjust to the new strategy. However, raising awareness among residents and companies is also crucial for when the strategy partly relies on the behaviour of residents and companies and how they act in and on their private property. An example of this is that as mentioned in the London strategy drivers took a detour to avoid being charged. It would be more beneficial for the environment if awareness was raised among the drivers immediately. Residents' behaviour could also be steered by granting subsidies as the subsidies could be a motivation for residents and companies to adjust. When taking multiple measures, the strategy can be included in many aspects of society, like residents,

companies, drivers, and many different sectors, like transport, consumption and the built environment. As a result, the environmental benefits will be seen throughout the different sectors and the economic benefits will be higher. Every strategy would have to be adjusted to fit a particular city as every city has a different urban plan with different law and regulations. Therefore, it depends on the city that wants to implement a strategy on how the strategy has to be implemented.

6. Lessons from each strategy

Which lessons can be drawn from each strategy that can be used for future strategies?

A lesson drawn from the strategy of Amsterdam is in the extent of the second value chain. Here, they focus on the reduction of electronics and repair them. However, consumers want to buy the newest electronics instead of repairing their old electronics as technology improves over the years and thus new electronics are of better quality than old electronics (Standford Graduate School of Business, 2004). Therefore, it would be more effective if the focus lies on recycling (parts of) old electronics instead of repairing them. A lesson drawn from the strategy of London is the necessity of providing information on electric vehicles. It is assumed that awareness is raised among drivers when they can't enter a zone and electric vehicles are purchased. However, when information and the advantages are provided on electric vehicles, drivers can get enthusiastic and will more easily purchase an electric vehicle. This is also the case in the Singapore strategy. Here, drivers need to purchase a cleaner-energy model. When only this information is provided and not about the different kind of models, it stays an ambiguous concept. The strategy will become more clear for the drivers when information is provided.

7. Conclusion

Three sustainability strategies, from the cities Amsterdam, London, and Singapore, have been analysed and compared. This has been done by explaining the content of the strategy, the implementation of the strategy, stating the environmental benefits, and the economic costs and benefits.

The analyses of the strategy from Amsterdam with 'Amsterdam Circulair 2020-2025' concludes that the strategy will result in a reduction of emissions of 48% by 2030 and of 83% by 2050, compared to 2012. This reduction is expected to be slightly lower for Amsterdam as this reduction is seen in three value chains, while Amsterdam only has two of these three value chains included in their strategy. However, this is compensated by the value chain of 'consumption goods'. Furthermore, this strategy includes sources that will reduce emissions, which will result in a reduction of the loss of resources and ease the burden on ecosystems. On the short term, the economic costs for this strategy will be high and the benefits will be low. However, on the long term, the economic benefits will increase.

The analyses of the strategy from London, with 'Zero Emission London', concludes that the strategy of implementing ULEZ and LEZ, will result in a reduction of NO2 and CO2 emissions.

In the first five months after implementing LEZs, there was an increase of PM10 because of behavioural adjustments. However, after these five months, PM10 decreased again. As a result of the reduction of NO2 emissions, the life expectancy of Londoners will increase, compared to 2020. Because of this increase in life expectancy, the economic benefits will be around £800 million (at 2014 prices). The charges for entering the zones can be seen as economic benefits as well. The costs of charging stations depend on their capacity: the higher the capacity, the higher the costs.

The analyses of the strategy from Singapore with 'Energy Reset' concludes that investing in green energy results in a reduction in greenhouse gasses and improves the energy efficiency by improving the total factor carbon productivity. Furthermore, adopting solar energy will reduce CO2 emissions. However, the energy demand does increase. This means that the reduction will be less than first anticipated. However, the demand decreases for air conditioning with the use of cool paint. This decrease will be larger when increasing the energy efficiency. Because of the increase in energy demand, the investments in grid infrastructure will cost relatively more. However, the economic benefit of using solar energy is high. When the energy efficiency is increased in buildings extra costs are made. Nonetheless, the building will save a lot of energy and thus the electricity costs will be low.

The lessons from each strategy regard to consumer behaviour. Consumers want to buy electronics instead of repairing their old electronics. Furthermore, providing information can have a positive effect on a person's behaviour. This change in behaviour will eventually lead to the goal, namely purchasing cleaner-energy and electric vehicles. Consumer behaviour is a crucial part in the three concerned strategies. It cannot be expected from consumers that they will do an expensive expenditure without all the information. Providing information is important when a part of the strategy relies on consumer behaviour. This could be improved in all three strategies and is crucial for future strategies. The innovativeness is going well in each strategy. Innovative ideas and products are used in every strategy which will increase both the environmental and economic benefits.

The strength of this research is that the costs and benefits are analysed from different views as they were usually not described in the strategy itself. A weakness is that the exact economic costs and benefits of each strategy are unknown. The strategies have been implemented for a short time or have not been implemented yet. This means that the exact costs are not known yet nor the exact economic benefits as the strategies have not been implemented long enough to know the economic benefits on the long term or even the short term.

Further research has to be done on how consumer behaviour is affected when information is provided. With this knowledge, strategies can strive for favourable consumer behaviour which will lead to an improvement in economic sustainability.

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9. Appendices

Content of appendices

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Appendix 3: Value chains from ‘Amsterdam Circulair 2020-2025’
Appendix 4: The different Zones in London
Appendix 5: Costs of charging station

Appendix 1: Framework for data analysis

	Amsterdam	London	Singapore
Strategy focusses on:			
Innovativeness			
Competitiveness			
Efficiency			
Consumer behaviour			
Reducing waste			
Reducing carbon emissions			
Reducing energy consumption			
Reducing water consumption			
Green energy			
Electric powered transport			
Waste management			
Recycling			
Switching to a more sustainable alternative			
Increasing the collaboration between companies/partners			
Why this strategy?			
Health benefits			
Environmental benefits			
Safety benefits			
Economic benefits			
Implementation of the strategy:			
Subsidies for companies and/or individuals			
Implementing/expanding fees, land rates and charges			
Making physical changes to the urban planning			
Raising awareness / changing behaviour			
Implementing new standards, laws and/or regulations			
Stimulating collaborations between partners and/or companies			
Government and municipality acting as an example			
Total			

Appendix 2: Framework for data analysis filled in

	Amsterdam	**London**	**Singapore**
Strategy focusses on:			
Innovativeness	V	V	V
Competitiveness	V		V
Efficiency	V		V
Consumer behaviour	V	V	
Reducing waste	V		
Reducing carbon emissions	V	V	
Reducing energy consumption			V
Reducing water consumption			
Green energy			V
Electric powered transport		V	V
Waste management	V		
Recycling	V		V
Switching to a more sustainable alternative	V	V	V
Increasing the collaboration between companies/partners	V	V	V
Why this strategy?			
Health benefits		V	
Environmental benefits	V	V	V
Safety benefits			
Economic benefits	V	V	V
Implementation of the strategy:			
Subsidies for companies and/or individuals	V		
Implementing/expanding fees, land rates and charges	V	V	
Making physical changes to the urban planning	V	V	V
Raising awareness / changing behaviour	V	V	
Implementing new standards, laws and/or regulations	V	V	V
Stimulating collaborations between partners and/or companies	V		
Government and municipality acting as an example	V		
Total	19	13	13

Appendix 3: Value chains from ‘Amsterdam Circular 2020-2025’ (Gemeente Amsterdam, 2020a)

Value chain	Content of the value chain	Implementation and policy instruments
Food and organic residual streams	- Create circular food production in urban areas - Stimulate a healthy, sustainable, and vegan food consumption by all residents - Minimalise food waste by retail, horeca, and households - Increase of separate collection of organic waste of households and companies for high quality processing - Increase of high-quality processing of biomass- and food residual stream - Speed up closing the local nutrient loop from biomass- and (waste)water residual streams	- Spatial planning → physical places for waste collection, reuse and for closing the material loops - Greenery in the city without a purpose can be used for city agriculture - Raising awareness about food waste - The municipality has a say at social institutions - Stimulating innovations and collaborating with companies to reduce waste and to improve organic residual stream
Consumption goods	- Reduce consumption and avoid over consumption - Stimulate high quality recycling of complex consumption goods - Stimulate joint and long-term use of products - Increase the number of local craft centres for repairing products - Create and use standardised products that are suitable for reuse, reparation, and recycling	- The municipality can act as an example as a consumer - Increasing the supply for sharing, reusing and repairing and making them more accessible - Collaborating with large retailers and making agreements on the responsibility of the producers - Collaborating with knowledge institutions for a better design and a better processibility of raw materials
Built environment	- Stimulate circular urban planning with an urban plan, an integral approach, and a climate adaptive construction with special attention for closing the material loop - Use circular criteria in the land allocation and contracts of all construction and infrastructural projects and in the public space - Develop buildings with adjusted functions and systems - Increase of circular disassembly and separate collection of waste - Use reusable and secondary construction materials - Stimulate circular renovation in the private and social housing construction	- Using influence on the spatial planning of space, as a client for public spaces and on realising its own housing and granting permits for construction and demolishing - Collaborating with corporations and developers for the existing city and the renovation of the city - Exploring adjusting and expanding the financial instruments → changing land rates, fees, and charges

Appendix 4: The different Zones in London (Mayor of London, 2021a)

Zone	Content	Daily charges for entering the zone without meeting the standards
Ultra-Low Emission Zones	- Nowadays only in Central London - From 25 October 2021, this zone will expand up to the North Circular Road and South Circular Roads, with the roads itself not included - Operates 24 hours a day, 7 days a week, every day of the year, except Christmas Day (25 December)	- £12,50 for most vehicle types, including cars, motorcycles and vans (up to and including 3,5 tonnes) - £100 for heavier vehicles, including lorries (over 3,5 tonnes) and buses/coaches (over 5 tonnes)
Low Emission Zones	- Nowadays in Greater London - From 1 March 2021, these zones, within the Circular Roads, will change to become like Ultra-Low Emission Zones. The standards will change to match the ULEZ	- £100 for vans or specialist diesel vehicles (over 1205 tonnes unladen weight up to 3,5 tonnes gross vehicle weight) or minibuses (up to 5 - £100 for HGVs, lorries, vans and specialist heavy vehicles over 3,5 tonnes as well as buses/minibuses and coaches over 5 tonnes - £300 for HGVs, lorries, vans and specialst heavy vehicles over 3,5 tonnes as well as buses/minibuses and coaches over 5 tonnes
Congestion Charge Zone	- In Central London only (same area as ULEZ) - Hybrid vehicles are no longer exempt from 25 October 2021 - Charge needs to be paid when the vehicle is driving through the zone between 7am and 10pm, every day, except Christmas Day (25 December)	- £15 for every vehicle
Low Emission Zones for Non-Road Mobile Machinery	- In Greater London - Particularly for the construction sector - The standards that the vehicle has to meet depend on where the construction site is located - For mobile machines, transportable industrial equipment, vehicles which are fitted with an internal combustion engine and not intended for transporting goods or passengers on roads	- There is no charge, the machinery that do not meet the standards are not allowed to enter the zone

Appendix 5: Costs of charging station (Xiangang Tang et al., 2011)

The original currency of the table was yuan. These costs are converted to euros.

Type	Capacity (in MW)	Initial investment (in euros)	Land acquisition costs (in euros)	Annual operating costs (in euros)
A	5.0	455,000	390,000	39,000
B	3.0	260,000	221,000	26,000
C	1.5	156,000	130,000	19,500