Circular Economy in Cities:
A Strategic Approach Towards a Sustainable Society?

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Thesis submitted for completion of Master of Strategic Leadership towards Sustainability, Blekinge Institute of Technology, Karlskrona, Sweden.

Abstract:
Increasing environmental and social pressure caused by human activity requires action toward a sustainable society. As our population grows and the proportion living in urban areas increases, cities are in a unique position to affect change. This has led to Circular Economy (CE) gaining momentum in municipalities as a tool for their city. Despite this momentum, there is lack of clarity about what CE is, how it can be most effectively implemented, and its relationship to strategic sustainable development (SSD).

This research synthesized definitions of CE used in the field and investigated 21 cities worldwide to see how their municipalities have implemented CE practices. Using the Framework for Strategic Sustainable Development (FSSD), the implemented actions were critically examined for their strategic contribution toward a sustainable society.

The findings suggest that CE is defined broadly, and interpreted differently by different users. In some cases, this presents challenges for its strategic use. The CE actions examined are concluded to be within the boundaries of a sustainable society, as defined by the FSSD. Their strategic approach is determined to be largely positive, with some exceptions. Depending on its application, CE is concluded to be a useful, albeit insufficient, tool for municipalities working toward SSD.

Keywords: circular economy, sustainable cities, strategic sustainable development, sustainability, urban development, FSSD
Statement of Contribution

Team CE has had an incredibly rewarding experience working together on this research, and we are proud of what we have created together. From reading literature and designing our research approach, through to data collection and analysis, we have taken a collaborative approach. We believe it is important that all of us have equal knowledge on the various parts of the thesis. All of us have rotated roles and responsibilities, provided equal input in discussions, and engagement in the process. Through insightful discussions about CE and sustainability, we all brought our passion and commitment to this project. Though we worked as a dynamic team, each member brought their own unique strengths to the process.

Patrick’s main strength throughout this research process has been his analytical mind and attention to detail. He fully immersed himself in the data and picked it apart until it fully made sense and we were able to use it for our results. His structured approach has ensured that the steps in our process are carried out in a thorough manner, and he has been the proponent of rigor in our research design. His eye for detail has saved us several times in the consistency and accuracy of the data collection and analysis. It is a great feeling to be able to trust your colleague in this intensive research process, and Patrick has given us added confidence in the quality of our research. In addition, his attention to detail has been invaluable for formatting and referencing, and he always made sure our files were backed up and uncluttered!

Cynthia’s energy and motivation has brought so much vitality to our project from beginning to end. She kept positive when the team was having doubts and was able to use her solution-oriented attitude to help us discover new possibilities and push us when we needed it. Her engagement and passion has shown through in every step of the process, bringing energy and creativity to discussions and lighthearted humor to the group. Cynthia is a clear and concise writer, always keeping an eye on the narrative of our text and clarity of communication. She was able to keep an overview of the project and keep the team on track, while still diving into the details. She is also a spreadsheet wizard, which was an invaluable asset throughout the process to provide structure and clarity, but particularly during the analysis of results.

Heather has provided our team with meaningful discussions, critical questions, and a great sense of direction. She showed her strength in asking the right questions during the process, pointing out things for consideration which may not have been obvious to the group, and helping the team to avoid pitfalls. As a quick thinker and processer, she has especially been a great sparring partner in justifications in our decision-making along the way. She was quick to step in when there was work to be done, and remained professional and committed throughout the process. Furthermore, she contributed to the group process with her excellent handwriting and visualization skills to design agendas, overviews or other material that supported us to facilitate our process. This creativity helped us to move forward, make sense of, and present intermediate results. It always felt effortless to work at her side. There was a great trust in the quality that she brought to the thesis, and her interest in the topic was incredibly inspiring as well.
It’s been a pleasure to work in this team. We have learned together and from each other throughout the process, and we look forward to future collaborations!

Patrick Lindner
Cynthia Mooij
Heather Rogers

Karlskrona, Sweden,
May 2017.
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This thesis has been a great journey of learning for us all, and it wouldn’t have been possible without a number of people who supported us through it, or contributed to the research in some way.

First of all, we wish to extend gratitude to our primary supervisor, Anthony Thompson, who has been a great support for us throughout this research period. Our meetings were not only filled with critical questions and feedback, but also a supporting attitude and trust in our abilities. We were also lucky to have a secondary supervisor, Lisa Wälitalo, available for us to fall back on when needed.

Furthermore, we would not have been able to have gone through this journey without the MSLS staff preparing us throughout the year and creating this wonderful ‘container’ of learning. They have prepared us not only content-wise, but also with regards to teamwork. Particularly in preparing us on how to make use of group dynamics, and work well together.

We were overwhelmed with the many positive responses and interest to contribute to our research. Each interview gave us new insights and provided another layer to the research. We would like to therefore thank all those that participated in our interviews (both written and verbal), in no particular order: Sladjana Mijatović, Sander Lubberhuizen, Marc Veenhuizen, Daniel Kietzer, Lance McNeill, Andrew Cook, Riikka Vilkuna, Andreas Sawatzki, Nina Wolf, Michiel Ruis, Alex Tuinstra, Yuki Tsuji, Takanori Arima, Malin Norling, Melina Planchenault, Saami Kalule-Sabiti, Håkon Jentoft, Katie Thomas, John Trujillo, Jonas Svensson, Ingeborg Berger, Steven Chiv, Chris Underwood, Patrick Chauo, Pietra Baslij, and Julia Vol.

Our families, friends, and significant others also deserve a shout out, for supporting us when the learning journey was bumpy, and listening to us when we needed it.

Last but not least, we also want to recognize the support we have received from all of our MSLS classmates, both in the form of feedback sessions in class and casual conversations during lunch or a potluck. It is an amazing feeling to have such a supporting and loving community of friends and colleagues.
Executive Summary

Introduction

Environmental degradation and climate change is a major global concern that impacts ecosystems, economies and communities around the world (Parmesan and Yohe 2003; Held and Soden 2006; Trenberth, Fasullo, and Shepherd 2015). With global population growth expected to reach 8.5 billion people in the next 15 years (UNDESA 2015a, 2), and 66% of the population expected to live in cities by 2050 (UNDESA 2015b, 7), municipalities are in a unique position to affect change toward a sustainable society. As the degradation of our socio-ecological system is systematically increasing, the need to find solutions grows more urgent. This challenge can be referred to as the sustainability challenge (Robèrt et al. 2015, 13).

A tool that is being used to address this sustainability challenge is Circular Economy (CE). CE originates from a combination of concepts including environmental economics, general systems theory, and industrial ecology. It is a concept that focuses on the redesign of products and processes “to maximize the value of resources through the economy with the ambition to decouple economic growth and resource use” (Ghisellini, Cialani, and Ulgiati 2016, 15). Although CE has traditionally been used in the industrial sector and product design, with cities consuming 75% of the world’s natural resources (UNEP 2013, 26), municipalities are beginning to turn to the concept as an opportunity for resource efficiency - combining both their sustainability and economic ambitions. This CE trend within municipalities is further motivated by increased political pressure (Ministry of Economy, Trade and Infrastructure 2010; European Commission 2015; Chinalawinfo 2017; German Law Archives, 2017).

This sustainability challenge is particularly difficult to navigate because of its high degree of complexity. Both systems thinking, and a clear direction or goal, are necessary to act strategically (Seiffert and Loch 2005, 1201; Broman and Robèrt 2017, 19). Backcasting from a clear definition of sustainability, as well as systems thinking, together enable Strategic Sustainable Development (SSD). The Framework for Strategic Sustainable Development (FSSD) is a unifying framework developed specifically to enable an SSD approach and provide clarity in such a context. It provides a principle based definition of sustainability and an operational planning procedure to guide the transition towards sustainability (Broman and Robèrt 2017, 20).

While CE is gaining momentum in cities, three main gaps have been identified in the research regarding its implementation: a lack of clarity about current implementation in cities (Ghisellini, Cialani, and Ulgiati 2016, 27), how that implementation contributes to a sustainable society (Geissdoerfer et al. 2017, 767), and whether or not it is being implemented strategically.

With these research gaps in mind, the purpose of this research is to understand the ways in which CE is currently being implemented by cities, and how this may contribute to the
strategic development of a sustainable society. With this information we aim to bring clarity to municipalities on whether or not CE can be used as a strategic tool to address sustainable development, and if so, how they might use their unique position to integrate this concept in their city.

Our research question asks: *How does the current implementation of circular economy in cities contribute to the strategic development of a sustainable society?*

The following three steps were carried out in order to answer this main question:

Step 1: Definition analysis, in which the definitions of CE in the field were explored and synthesized.

Step 2: Overview of CE actions was generated, giving an indication of CE activities in cities around the world.

Step 3: Assessment of CE actions in cities about their contribution to the strategic development of a sustainable society.

**Methods**

Our research was conducted with a pragmatic research approach. This was supplemented by the previously mentioned Framework for Strategic Sustainable Development (FSSD) as an overarching lens. It was chosen because it clearly defines the system to be sustained, applies systems thinking, and includes a principle-based definition of sustainability (Robèrt 2000; Broman and Robèrt 2017). Following the overall approach and FSSD lens of our research, several methods were allocated to the different research steps:

*Summarized Research Methods*

<table>
<thead>
<tr>
<th>Research Steps</th>
<th>Data Collection Method</th>
<th>Data Analysis Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1: CE definition analysis</td>
<td>17 semi-structured interviews and five written interviews with municipalities actively working with CE. Documents.</td>
<td>Thematic analysis in order to synthesize 35 CE descriptions into an overall definition and descriptive principles.</td>
</tr>
<tr>
<td>Step 2: Overview of CE actions in cities</td>
<td>The same interviews and written interviews as Step 1. Documents.</td>
<td>Classic content analysis, to extract descriptions of 87 CE actions and use open coding to categorize them.</td>
</tr>
<tr>
<td>Step 3: SSD assessment of CE actions</td>
<td>The 87 CE actions collected in Step 2.</td>
<td>FSSD-Assessment, in order to assess the 87 CE actions against the eight sustainability principles and three strategic questions.</td>
</tr>
</tbody>
</table>
Results

Our first research step synthesized 35 definitions from CE practitioners and municipalities from various regions of the world into one overarching definition and nine principles:

**Synthesized Definition of Circular Economy**

**Circular economy** is a model that looks at human society from a systems perspective, where both technical cycles (using innovation to close the loop for materials and products), and biological cycles (the cycle of organic material and nutrients) are recognized. Preference is given for cycles that are being closed on a local scale for both. The following nine principles show the different enabling aspects of this model:

1. Waste is a resource, and therefore materials are efficiently recycled and upcycled to maintain their highest value for as long as possible;
2. Design is intentional. Systems have a service-based preference and materials are designed for recycling, upcycling, and longevity;
3. Social sustainability is enhanced through sharing and collaboration while simultaneously stimulating economic development and opportunities;
4. Innovative business models are used as an enabling tool;
5. Systems take inspiration from ecology and living systems, where both materials and nutrients are cycled to restore and regenerate the economic and ecological system;
6. Both financial and natural capital are recognized and new value is generated through the cycling and restoration of materials;
7. Energy usage is reduced and comes from renewable sources;
8. The system is designed to be both resilient and adaptive through flexible design, diversification, and risk mitigation; and
9. The ecological system is preserved by supporting biodiversity, eliminating toxic materials and managing externalities.

Our second research step found 87 CE actions in 21 different cities. Ultimately divided among a total of 12 categories, the most occurring action categories were: ‘Collaboration’, ‘Business’, ‘Platform’, and ‘Policy’. The 22 subcodes within these actions showed emphasis on ‘Innovation’, ‘Business’, and ‘Material Use’. When comparing this with the CE definition synthesized in our first research step, the CE actions in practice were found to be largely aligned.

Our third and final step to answer our research question, assessed the 87 actions on their contribution to SSD. Here we used the 8SPs and three strategic guideline questions. We found that the vast majority fell within the boundary conditions for a sustainable society provided by the FSSD. Most actions also aligned by providing a stepping stone for other actions and providing a positive impact on citizens. However, a large amount of actions (39.7%) could not provide potential financial savings or revenues, which was mostly due to the action being a collaboration, platform, or policy.
Discussion

In our first research step, we synthesized CE definitions and found that the understanding in the field had a broad scope. However, there was consensus around the category of ‘Waste as a Resource’, which was expected based on the Industrial Ecology roots of CE. The importance of having a clear definition is emphasized, as it allows a municipality to act strategically towards it. This strategic approach may further be diminished by the descriptive format of the CE definitions and the many pillars that are used to describe the term. Both can create misunderstanding of what level of alignment is sufficient to classify an action as CE. In its essence however, the synthesized definition of CE that reflects the understanding of the field, embraces a systems perspective. This shows the potential of CE as a useful tool in complement with the FSSD.

In our second research step, when examining the most common CE actions within cities, research showed a significant amount of business involvement. Municipalities were using tools like procurement policies and incubators to create both a new market and new solutions for CE. National and international collaborations (e.g. EMF Circular Cities Network) was also common among municipalities, reflecting a need for better understanding and showing commitment to building capacity around CE. Furthermore, it was noted that the lack of CE-related energy and water projects implemented indicated a significant future opportunity for municipalities.

Research indicated an alignment between the theoretical understanding of CE, and how it is being practiced. A notable theme from both is the prevalence of ‘Human Society’ as a category, which emphasizes the relevance of the CE concept for application in municipalities, as it highlights the potential for benefits to citizens.

Results from research step three showed that the vast majority of CE actions implemented by municipalities were occurring within the boundary conditions of a sustainable society, as defined by the eight sustainability principles. The few ones that did not were mainly due to a reliance on nonrenewable energy, indicating a need to build system-level capacities for renewable energy that can work in conjunction with smaller scale actions.

When assessing the actions on their strategic approach, the majority of actions were found to have a positive impact on citizens, and also provide a flexible platform for future projects, generally in the form of building partnerships, creating new business/markets, and increasing their own awareness.

Our results showed a deficiency in the financial strategic approach of many CE actions assessed, correlating with the pattern of collaboration, policy, platforms, and communication that arose. We also note, however, that the importance of this aspect may be diminished in the context of the mandate of cities. In this case, the combination of actions that produce financial
return and those that do not may serve to support each other and enhance the strong integration of CE in the city context.

In summary, our results show that the majority of actions being implemented are strategic in nature. This indicates that CE is an appropriate tool for municipalities wishing to contribute to SSD.

Recommendations
A number of recommendations can be made to municipalities implementing CE: recognizing the leveraging their areas of influence, adapting to their cultural context, considering the system-level barriers and opportunities, and providing internal education to embed the concept within the municipality.

Strengths and Limitations
The limitations of our research may include preconceived notions about sustainability derived from our backgrounds, the scope of the cities interviewed, the open-coding method, and interviewee bias. We also recognize that the scope of our research, combined with the limited time frame, resulted in a higher-level, less detailed SSD assessment. The latter can also be identified as a strength as it allowed for trend identification. Furthermore, the focus on implemented actions rather than plans or ambitions, grounded the findings in reality and adds to their practical use.

Further Research
Further research can be recommended to investigate: the connection between the role of a municipality and the stage of CE in their city, the influence of culture on the role of a municipality for CE implementation, how actions on different system scales can be leveraged for impact amplification, and how CE can be most effectively embedded within a municipality. Finally, there is also room for clarity on research on what a ‘circular city’ would look like, and whether this is a desirable end state.

Conclusion
Overall, we found that the current implementation of CE by municipalities contributes to the strategic development of a sustainable society. It does so by enabling capacity building within the city and using CE as a tool to marry sustainability goals and economic ones. If CE implementation continues in this way, it will continue to contribute to SSD. This way of applying CE as a tool, however, may limit the opportunity presented by the concept. The systems perspective of CE holds potential for radical systems change, while its current understanding and use, as well as its placement embedded within the current system, does not foster that potential. Based on the findings of this research, at this stage, CE can be used by municipalities in complement with other tools available to move towards the larger goal of a sustainable society.
Glossary

**Backcasting:** Backcasting is an approach for strategic planning, whereby first, a desired vision is formulated, followed by the development of subsequent steps to reach this vision (Robinson 1990, 822-823; Broman and Robèrt 2017, 19). Backcasting allows alternative development paths to reach this vision (Robinson 1990, 823).

**Biological Cycle:** Referring to the closed loop cycle of “materials that can biodegrade safely and return to the soil to feed environmental processes.” (Cradle to Cradle Products Innovation Institute 2017).

**Closed Loop:** A processing system in which a resource is cycled through different uses indefinitely, while maintaining its highest value.

**Concept:** an abstract idea; a general notion.

**Framework for Strategic Sustainable Development (FSSD):** The Framework for Strategic Sustainable Development (FSSD) is a unifying framework developed to provide clarity and precision to the field. The FSSD describes the sustainability challenge through a funnel metaphor, includes a structuring model that provides the space to deconstruct and analyze a complex issue on different levels. It also provides a unique principle-based definition of sustainability and an operational planning procedure to guide the transition towards sustainability (Broman and Robèrt 2017, 20).

**Industrial Ecology:** The concept takes inspiration from the biological ecosystem, where “each process and network of processes must be viewed as a dependent and interrelated part of a larger whole” (Frosch and Gallopoulos 1990, 793), and applies this within different industrial facilities and processes. In this way, industrial ecology promotes the transition from linear industrial flows to a closed cycle of materials and energy (Erkman 1997, 1).

**Municipality:** A primarily urban political unit having corporate status and usually powers of self-government.

**Network:** A group or system of interconnected people or things.

**Organization:** An organized group of people with a particular purpose, such as a business, association, or municipality.

**Procurement:** The action of obtaining or buying something.

**Recycle:** Convert (waste) into reusable material.

**Sustainability Challenge:** As the degradation of our socio-ecological system is systematically increasing, the need to find solutions grows more urgent (Robèrt et al. 2015, 13).
**Sustainability Principles:** There are eight sustainability principles within the FSSD that define a sustainable society. In a sustainable society nature is not subject to systematically increasing (1) concentrations of substances extracted from the earth’s crust; (2) concentrations of substances produced by society; and (3) degradation by physical means. In that society, people are also not subject to structural obstacles to (4) health; (5) influence; (6) competence; (7) impartiality; and (8) meaning-making (Broman and Robèrt 2017, 22).

**Technical Cycle:** Referring to the closed loop cycle of a material as it infinitely cycles through manufacture, reuse and recovery while maintaining its high value (Cradle to Cradle Products Innovation Institute 2017).

**Upcycle:** Reuse (of discarded objects or material) in such a way as to create a product of a higher quality or value than the original.

**Waste:** Material or substance eliminated or discarded as no longer useful or required after the completion of a process.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>8SPs</td>
<td>Eight Sustainability Principles</td>
</tr>
<tr>
<td>CE</td>
<td>Circular Economy</td>
</tr>
<tr>
<td>C2C</td>
<td>Cradle to Cradle</td>
</tr>
<tr>
<td>EMF</td>
<td>Ellen MacArthur Foundation</td>
</tr>
<tr>
<td>EPS</td>
<td>Expanded Polystyrene</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FSSD</td>
<td>Framework for Strategic Sustainable Development</td>
</tr>
<tr>
<td>ICLEI</td>
<td>International Council for Local Environmental Initiatives</td>
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<tr>
<td>IE</td>
<td>Industrial Ecology</td>
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<tr>
<td>MSLSS</td>
<td>Masters in Strategic Leadership towards Sustainability</td>
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<tr>
<td>SG</td>
<td>Strategic Guideline</td>
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<tr>
<td>SSD</td>
<td>Strategic Sustainable Development</td>
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<tr>
<td>SP</td>
<td>Sustainability Principle</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNDESA</td>
<td>United Nations Department of Economic and Social Affairs</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<tr>
<td>WCED</td>
<td>World Commission on Environment and Development</td>
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1 Introduction

The following chapter will introduce the complexity of the environmental challenges facing society and the planet, and the increasingly important role that cities play in addressing those challenges. The concept of circular economy will be introduced as a possible tool and its theory and practice will be described. The need for strategic sustainable development is elaborated on, and the Framework for Strategic Sustainable Development that enables this approach is introduced. As cities are facing increasing top-down pressure to embed this concept in their operations, we will look at the research gaps that present barriers for this, and introduce the research this paper will focus on.

1.1 The Sustainability Challenge and Urbanization

Current environmental degradation and climate change is a major global concern that is impacting ecosystems, economies, and communities around the world (Parmesan and Yohe 2003; Held and Soden 2006; Trenberth, Fasullo, and Shepherd 2015). Impacts are so severe that scientists now describe the current geological epoch as the “Anthropocene” era, in which human activities are dominating the natural environment (Crutzen 2006; Steffen, Crutzen, and McNeill 2007). As the degradation of our socio-ecological system is systematically increasing, the need to find solutions grows more urgent. This challenge can be referred to as the sustainability challenge, and is illustrated in Figure 1.1 using the metaphor of a funnel. The narrowing of the funnel walls represents the “reduction in the room to maneuver” due to increasingly scarce resources and environmental pressure. The eventual leveling out of the walls then symbolizes the goal of “the steadying of the socio-ecological system once society has become sustainable” (Robèrt et al. 2015, 13).

![Figure 1.1: The Funnel Metaphor.](image)

As the degradation of our socio-ecological system is systematically increasing, the need to find solutions grows more urgent.
(Adapted from Robèrt et al. 2015, 13)

Growth of the global population is making the sustainability challenge even more complex, adding environmental and social pressure. In 2015, the population reached 7.3 billion, and continued growth is expected, with projections of 8.5 billion people in the next 15 years.
Population growth is expected to concentrate especially in urban area. The United Nations (UN) states that close to 54% of the world's population currently lives in cities; this figure is expected to grow to 66% by 2050 (UNDESA 2015b, 7). Cities are thus facing an unprecedented pressure to plan for urban growth while limiting their environmental impact. Traditional urban planning and management is being challenged to move towards “the far more demanding objectives of achieving inclusive, equitable and sustainable cities.” (Watson 2009, 191).

One of the challenges that municipalities face to reach an objective of a sustainable city is regarding resources. Cities consume 75% of the world’s natural resources (UNEP 2013, 26). This large consumption is coupled with significant amounts of waste that municipalities carry responsibility over. For instance, the city of London generated 858 kg household waste per household in 2015/2016 (London Datastore 2016). With millions of people living in this metropolitan city, managing this waste flow in a sustainable manner can be challenging. A variety of questions arise regarding how the municipality handles these flows: Are they centrally managed? How are they processed? Where do the nutrients end up? Both resource inputs and waste outputs of cities come with social and environmental impacts (Newman 1999, 220). However, research also indicates that growing urbanization has the potential to actually decrease environmental impact (Salim and Shafiei 2014, 587). This decreased impact is said to be achieved by using the high density in cities to increase resource efficiency, provide more support for sustainable modes of transportation, and provide more economically viable infrastructure due to the lowered cost per capita (Williams 2014, 1). This nexus of resource management provides municipalities with the opportunity to be a leverage point in the transition towards a sustainable city; as Dale, Dushenko and Robinson (2012, 87) observe, “as both contributors to the problem and incubators of capacity and infrastructure, communities and local governments recognize the fundamental role they might play in the broad urban sustainability agenda.”

1.2 The Origin of Circular Economy

One of the suggested tools in the transition to sustainability is the concept of circular economy (CE). It has been argued that CE is a new school of thought (Murray, Skene and Haynes 2015, 377) that presents feasible and comprehensive solutions for sustainable development (Bonciu 2014, 89; Sauvé, Bernard, and Sloan 2016, 54). This concept of CE has evolved over time from a variety of theories, as will be elaborated on in this subchapter.

In 1966, American economist Kenneth Boulding (1966) introduced the concept of a cyclical system that is regenerative and zero-waste, where the finite resources on earth are recycled and their value is optimized. He explains that, “the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system” (Boulding 1966, 9).
Although the term ‘circular economy’ is not used, Boulding has been credited as presenting an early CE theory.

The concept of CE has since evolved with the help of several existing theories and concepts, most importantly *Environmental Economics*, *General Systems Theory* and *Industrial Ecology* (Figure 1.2).

*Environmental Economics*

Environmental Economics was a precursor to CE as it advocates for the transition from a traditional open-ended economic system to a more ‘circular’ one. In fact, the word “circular economy” was first mentioned by environmental economists (Pearce and Turner 1990). According to Pearce and Turner (1990), the concept of Environmental Economics consists of four basic provisions of the environment; amenity values, a life support system, a sink for waste and emissions, and a resource base for the economy. Environmental Economics attempts to internalize environmental externalities using product and service pricing, and CE borrows this idea (Ghisellini, Cialani, and Ulgiati 2016, 14). Anderson (2007, 139) suggests that “although the available estimates for external effects provide only a partial and incomplete picture of the environmental costs at stake, they help support and expand on the analysis of the virtues of a more circular economy”.

*General Systems Theory*

General Systems Theory, was first introduced in the 1920s by biologist von Bertalanffy and has also informed the CE concept (Ghisellini, Cialani, and Ulgiati 2016, 14). Von Bertalanffy found that “the then prevalent mechanistic [scientific] approach [...] appeared to neglect or actively deny just what is essential in the phenomena of life” (1968, 12). While traditional scientific theory suggests one can derive understanding of the whole through the cumulative understanding of the constituent parts, Systems Theory shifts that paradigm by suggesting that actually “the properties of the parts can only be understood through the dynamics of the whole” (Capra 1985, 476). This pattern of connective, complex thinking is fundamental to the CE concept, as it allows for the synergies within or among systems to be revealed and realized. In addition, Boulding (1956, 199) argues that the objective of a general systems theory is to create a better understanding and ability to communicate among the different scientific disciplines. This connection of disciplines is also foundational within the concept of CE, where different actors often collaborate to realize the mutual value gained through efficient use.
Industrial Ecology

Industrial Ecology (IE) is also an important concept linked to the development of CE (Murray, Skenes, and Haynes 2015, 372). The concept takes inspiration from the biological ecosystem, where “each process and network of processes must be viewed as a dependent and interrelated part of a larger whole” (Frosch and Gallopoulos 1990, 793), and applies this within different industrial facilities and processes. In this way, IE promotes the transition from linear industrial flows to a closed cycle of materials and energy (Erkman 1997, 1). Industrial symbiosis is one application of this concept, and occurs when efficiency is optimized through cascading use of energy and use of industrial byproducts (Gertler 1995, 14) in order “to obtain a collective benefit greater than the sum of benefits that could be achieved individually” (Álvarez and Ruiz-Puente 2016, 2). This transition to cyclical flows is at the core of CE, but expanded beyond just industrial processes and systems.

1.3 Circular Economy in Practice

As the origin of CE is based in the industrial sector, it is not surprising that many CE related projects still occur in this sector. Industrial eco-parks are a very prevalent example of this, such as the Kalundborg Symbiosis industrial eco-park in Kalundborg, Denmark. This industrial eco-park includes eight large public and private enterprises that exchange 27 separate waste streams (Kalundborg Symbiosis 2017), creating links between industrial processes and matching demand with supply for resource inputs and outputs.

CE has also been integrated into consumer product design. For example, Dell implemented a closed-loop recycled plastics supply chain for its computers by designing for recyclability and launching a take-back program for consumers (Dell 2017). In another case, Timberland teamed up with a tire manufacturer to design a line of vehicle tires that can easily be broken down and recycled into Timberland shoes after their first use phase has ended (Timberland 2017).

These examples of CE show different system levels to which the concept can be applied. For example, municipalities can also scale the CE model to the city system. This application shifts the focus to the design of public services that the city offers, rather than product or material design. Municipalities are using CE as an opportunity to pursue both economic and environmental objectives simultaneously and the concept is already being integrated into municipal sustainability policies. The city of Amsterdam, for example, calls the integration of CE a pillar of their sustainability policy (Circle Economy 2016, 4). On the other hand, the city of Vancouver has integrated CE into their Economic Commission branch (Vancouver Economic Commission 2017a).

Although there are many examples of how CE is currently being utilized, the working definition varies greatly. An in-depth review from Ghisellini, Cialani, and Ulgiati (2016, 15) concludes that in a circular economy “products and processes are redesigned to maximize the
value of resources through the economy with the ambition to decouple economic growth and resource use”. This is representative of many descriptions, which focus on resource use based on traditional applications of product design or industry efficiencies. The Cradle to Cradle (C2C) framework also presents the distinction of materials as either biological or technical nutrients. Technical nutrients refer to a material that maintains its high value as it infinitely cycles through manufacture, reuse and recovery. Their meaning of biological nutrients are “materials that can biodegrade safely and return to the soil to feed environmental processes” (Cradle to Cradle Products Innovation Institute 2017).

1.4 Political Pressure towards Circular Economy

The concept of CE is gaining momentum in the political field. This is partly due to an increased global commitment to address sustainability, as reflected in the recent Paris Agreement, ratified on November 4, 2016 (UNFCCC 2017). This subchapter will outline some of the top-down pressure for CE implementation in municipalities.

CE has now been embraced by many countries as a viable economic reform model to allow continued economic growth (Winans, Kendall, and Deng 2017, 827). Germany, Japan and China pioneered the concept by adopting national policies. Japan adopted the Promotion of Effective Utilization of Resources Act 1991, which promotes recycling waste back into the value chain (Ministry of Economy, Trade and Infrastructure 2010, 10). CE was also integrated into Germany’s national laws in 1996 in the form of a Closed Substance Cycle and Waste Management Act (German Law Archives, 2017). China announced the Circular Economy Promotion Law of the People’s Republic of China Act 2008, with the specific purpose of “promoting the development of the circular economy, improving the resource utilization efficiency, protecting and improving the environment and realizing sustainable development.” (Chinalawinfo 2017).

Recently, the European Union (EU) has begun applying top-down pressure on its member states to transform Europe’s economy into a sustainable one. To encourage resource efficiency, the EU has prioritized a CE approach. In fact, on December 2, 2015 the European Commission announced the CE stimulus package “Closing the loop - An EU action plan for the Circular Economy” which calls for “a continued, broader commitment from all levels of government, in Member States, regions and cities and all stakeholders concerned” (European Commission 2015). The package suggests proposals for new legislation to incentivize CE actions, funds for CE investments, and funds for research into topics within CE (European Commission 2015). Other policies, like EU targets for recycling and waste management (e.g. having to reduce landfill to maximum 10% of municipal waste by 2030), are already indirectly stimulating countries and municipalities to integrate CE.

This top-down pressure explains why some cities are increasing efforts toward efficient resource planning. These efforts are reflected in the proliferation of networks among cities,
where knowledge and innovation is exchanged and encouraged. International networks for cities include the International Council for Local Environmental Initiatives (ICLEI), the EU Covenant of Mayors, the Climate Alliance, and the C40 Climate Leadership Group (C40 cities). With the recent launch of the Circular Cities Network by the Ellen MacArthur Foundation (EMF), some cities are now also specifically organized around the implementation of CE.

While CE is gaining momentum and political pressure is increasing, some criticism and concerning questions have been raised by researchers. As CE can be seen as a paradigm shift from the linear economy, the complexity of this shift is criticized by Gregson et al. (2015, 235) to be ‘ideal’. This is because it “require[s] radical transformations to the economic order, including fundamental recasting of manufacture, retail, consumption and property rights” (ibid.). Anderson (2007, 134) questions how far recycling can be taken, as “a circular economy cannot promote recycling in perpetuity.” Furthermore, Sauvé, Bernard, and Sloan (2016, 55) argue that “the circular economy puts the environmental sustainability forward, acknowledges the need for a favorable economic context (the circular model), but the social objective is usually absent.” These criticisms and questions must also be taken into account, particularly when understanding CE and evaluating its larger contribution to sustainable development.

### 1.5 Strategic Sustainable Development

Tools and concepts like CE are often connected to the umbrella terms ‘sustainability’ or ‘sustainable development’. Over time, the understanding of these terms has developed together with the socio-ecological challenges they try to meet (Du Pisani 2006). In the course of this development there have been various attempts to create definitions of sustainability. One of the first, and still most common, definition of sustainable development comes from the World Commission on Environment and Development (WCED, also referred to as the Brundtland-commission). It defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987, 43). This definition has received various criticism for its vagueness (Missimer 2015, 2). Dale, Dushenko and Robinson (2012, 85) criticize the limited operationalization of it in the context of cities in particular, as “it fails to capture the complexities of urban sustainability, particularly when it is used as a foundation for informing action”. The vagueness and limited operationalization of this and similar definitions promoted unclarity in the field of sustainability and led to a number of tools, method and terms to approach sustainable development (Robèrt et al. 2002, 197; Glavić and Lukman 2007).

The difficulty of finding a holistic definition of sustainability or sustainable development may also be because the socio-ecological system that sustainability tries to sustain is a complex system. A complex system is characterized by a large number of interacting elements involved, with the system being constantly dynamic, and the interactions being non-linear.
This non-linear relationship means that small changes can have unexpectedly large effects (Snowden and Boone 2007, 71). With the unclarity in the field of sustainability, this indicates the need for a more precise and systemic approach to counter the challenges that appear in this complex system.

To address the challenges in the complex field of sustainability, systems thinking is required (Seiffert and Loch 2005, 1201). Systems thinking is a way of working in and understanding complexity or complex systems (Capra 1985, 475). The focus shifts from reductionism and a focus on individual elements to a holistic view with emphasis on connections inside and between different systems (ibid.).

In addition to systems thinking, a clear direction or goal is needed to address the sustainability challenge (Broman and Robèrt 2017, 19). There are two major planning approaches when creating a strategy: forecasting and backcasting. The more prevalent approach, forecasting, projects current trends based on current possibilities and solutions onto the future (Robèrt 2000, 244). However, this approach is not appropriate to address such complex challenges as it carries the risk to transfer the roots of the problems and challenges into the future (ibid.). To address complex and long-term problems, backcasting, as a more systematic approach, has the potential to create more accurate results. When applying backcasting, a desired vision is first formulated, followed by the development of subsequent steps to reach that vision (Robinson 1990, 822-823; Broman and Robèrt 2017, 19), allowing alternative development paths (Robinson 1990, 823).

As pointed out, backcasting from a clear definition of sustainability, as well as systems thinking, together enable Strategic Sustainable Development (SSD).

### 1.6 The Framework for Strategic Sustainable Development

As mentioned in the previous subchapter, the unclarity in the field of sustainability has led to the development of various tools and methods to approach sustainability. A framework that adapts an SSD approach is the Framework for Strategic Sustainable Development (FSSD). The FSSD describes the sustainability challenge through a funnel metaphor (illustrated in chapter 1.1), and defines sustainability by using concrete principles (Broman and Robèrt 2017, 20). To further operationalize the definition of sustainability, the framework includes a structuring model that provides the possibility to deconstruct and analyze a complex issue on different levels, as well as an operational planning procedure to guide the transition towards sustainability (ibid.).

The eight sustainability principles (8SPs) are a core part of the FSSD. They serve as exclusion criteria, “constituting the boundary conditions within which society can continue to function and evolve, outside of which it cannot” (Broman and Robèrt 2017, 23). These principles (Table 1.1) provide the space to develop a vision within the boundaries of a sustainable society (Figure 1.3), thus enabling backcasting.
The 8SPs are based on scientific knowledge of the socio-ecological system to be sustained, and were developed through an iterative consensus process (Broman and Robèrt 2017, 17;22-23). According to the authors of the FSSD, the definition finds the balance between being “generally applicable and still sufficiently concrete” (Broman and Robèrt 2017, 22).

The sustainability principles (SPs) are as follows:

Table 1.1: Sustainability Principles of the FSSD.

<table>
<thead>
<tr>
<th>In a sustainable society, nature is not subject to systematically increasing…</th>
<th>In that society, people are not subject to structural obstacles to…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. … concentrations of substances extracted from the earth’s crust;</td>
<td>4. … health;</td>
</tr>
<tr>
<td>2. … concentrations of substances produced by society;</td>
<td>5. … influence;</td>
</tr>
<tr>
<td>3. … degradation by physical means.</td>
<td>6. … competence;</td>
</tr>
<tr>
<td>7. … impartiality;</td>
<td>8. … meaning-making.</td>
</tr>
</tbody>
</table>

(Broman and Robèrt 2017, 23)

The FSSD is specifically designed to work in complex contexts, making it particularly relevant to CE. As Dale, Dushenko and Robinson (2012, 85) point out, “given that simplistic definitions drive simplistic approaches, the future success of sustainability necessitates strategic initial positioning”. The concrete, principle-based boundary conditions for a sustainable society provided by the 8SPs build a foundation for action, like integrating CE, while the framework itself adds a strategic component.
1.7 Research Gaps

The previous subchapters have reflected on CE as a tool for municipalities to address the sustainability challenge, and have introduced the importance of an SSD approach and the FSSD to do so. With this information in mind, three main research gaps have been identified.

The first is a lack of clarity about the current reality of CE in cities. Although there is talk about CE application, and many visions are being published, increased knowledge around the theoretical and practical framework of the concept and the monitoring of existing projects is needed (Ghisellini, Cialani, and Ulgiati 2016, 27). Research has been done on CE in specific regions or cities (e.g. Geng et al. 2009; Ilic and Nikolic 2016; Schneider et al. 2016), and some more recent studies are looking at CE implementation on an aggregate scale (Winans, Kendall, and Deng 2015). However, none have explored a combination of these, in which CE implementation within a large set of municipalities is analyzed.

In addition to not having an aggregate overview of the CE landscape in cities, it is unclear how CE in its current implementation is contributing to a sustainable society, as pointed out by Geissdoerfer et al. (2017, 767). While cities have been identified as important actors in the sustainability challenge, and CE is increasingly used as a tool by municipalities of cities, there is a lack of research to connect CE in cities and their contribution to sustainable development.

The third research gap is about the lack of understanding of whether or not CE is being applied in a strategic way in cities. This requires an understanding of how municipalities define CE and if their actions can support a goal of a sustainable society. Having sustainability as a general objective can be an especially complex task (Glavič and Lukman 2007; Robèrt et al. 2002, 213) and having a clear goal definition is required in order to assess the strategic nature of CE towards sustainability. Bechtel, Bojko and Völkel (2013, ix), in their research on CE in multinational companies, already point to a “missing common definition as well as a lack of strategic guidelines and concrete measures” which create significant barriers to the diffusion of CE. Whether or not this is the case within municipalities, is not yet clear.

To understand CE’s relevance toward strategic sustainable development, it must be properly defined, and the context of CE in cities must be clearly understood.

1.8 Purpose of Research

The purpose of this research is to understand the ways in which CE is currently being implemented by cities, and how this may contribute to the strategic development of a sustainable society. With this information, we aim to bring clarity to municipalities on whether or not CE can be used as a strategic tool to address sustainable development, and if so, how they might use their unique position to integrate this concept in their city.
1.9 Research Question and Research Design

The research question for this thesis is:

*How does the current implementation of circular economy in cities contribute to the strategic development of a sustainable society?*

In order to answer the research question, the research design is divided into three steps. The first two steps run parallel and provide an understanding of the use of CE, on a conceptual level and practical level. The third research step provides a connection between what is happening in cities and its contribution to the strategic development of a sustainable society.

Step 1: Definition analysis, in which the definitions of CE in the field are explored and synthesized.
Step 2: Overview of CE actions is generated, giving an indication of CE activities in cities around the world.
Step 3: Assessment of CE actions in cities about their contribution to the strategic development of a sustainable society.

A summary of the research design is outlined in Figure 1.4 below:

![Figure 1.4: Overview of the Research Design.](image)

1.10 Scope and Limitations

The main audience for this research are municipalities or governmental departments who are interested in integrating CE in their city. Our secondary audience includes researchers who are exploring the topic of CE in cities.
The geographical scope of the actions is global, with a natural majority of cities located in Europe or North America. The cities contacted were publicly leading in the CE field and found through search criteria, previous networks, and recommendations.

Our research is focused on CE projects that are directly or indirectly connected to municipalities. This means that the CE projects are either initiated, facilitated, or supported by a municipality. Our research therefore does not include CE projects in the city that do not have clear involvement from the municipality.
2 Methods

The following chapter will first discuss the research paradigm chosen and the FSSD lens through which we approached the topic of CE in cities. The methods of data collection and analysis of each of the three steps of our research are then elaborated upon.

2.1 Overarching Research Paradigm

A pragmatic research approach was used to answer our research question. A pragmatic research approach is “an approach that draws upon the most sensible and practical methods available in order to answer a given research question” (Savin-Baden and Howell Major 2013, 171). This approach is particularly relevant to our study, as we are working with a limited time frame (five months), focusing on a practical topic, using a combination of different data collection methods, staying close to the data during our interpretation phase (mainly relying on description), and maintaining an external researcher voice.

2.2 FSSD Lens of the Research

As introduced in chapter 1.5, SSD is a concept developed to strategically approach the sustainability challenge. The FSSD, as described in chapter 1.6, adapts this approach and provides a five-level structuring model to deconstruct and analyze a complex issue on different levels (Broman and Robèrt 2017, 20).

The FSSD with several of its key components was used in this research as an overall methodology to approach the topic. The five-level structuring model of the FSSD aided in the understanding and analysis of CE in cities, its relation to SSD and the socio-ecological system on different levels. The five levels (Figure 2.1), and their specific relation to our research are described below in detail: System, Success, Strategic Guidelines, Actions, and Tools.

Figure 2.1: The Five Levels of the FSSD.
(Adapted from Robèrt et al. 2015, 36)
**Systems**

The systems level of the FSSD describes the conditions for the functioning of the global system which especially includes human society within the biosphere (Broman and Robèrt 2017, 22). For the purposes of our research, we have looked at the concept of CE in cities within a nested system model (Figure 2.2), where the city system is included within and affects the larger social system, which in turn is embedded within and affects a wider biosphere system. The entire global system is referred to as the socio-ecological system, which is highly complex and has been put under threat by environmental and social pressures. This research will look at the effect that CE within the city system has on the ability of the socio-ecological system as a whole to sustain itself.

**Success**

The success level of the FSSD describes the principles of a desired future. The FSSD avoids describing a concrete and detailed end state, but, as shown in chapter 1.6, it draws eight boundary conditions for a sustainable society, which leaves space for different designs of that end state and how to reach it (Broman and Robèrt 2017, 22).

Part of this research is to assess different CE initiatives in a standardized way based on their contribution to the strategic development of a sustainable society. The 8SPs of the FSSD provide clear boundary conditions for such a society that make an assessment less open to interpretation than an open, descriptive definition of sustainability. Additionally, the 8SPs have the benefit of aiming to be as generally applicable as possible, which enables the assessment of diverse actions in the field of CE in cities. Using a definition of a sustainable society helps us to place CE in the development towards such a society.

**Strategic Guidelines**

The level of strategic guidelines (SG) provides guidance “for how to approach the principle-framed vision strategically” (Broman and Robèrt 2017, 22). To do so, three generic questions are used in the FSSD for prioritization purposes:

1. Does the action proceed in the right direction with respect to the Sustainability Principles?
2. Does this action provide a “stepping stone” (flexible platform) for future improvements?
3. Is this action likely to produce a sufficient return on investment to further catalyze the process?

(Robèrt et al. 2015, 44).
Our research adapts these questions in order to assess the strategic nature of CE actions towards the development of a sustainable society. Assessing the strategic approach of the actions taken by cities is important to form an understanding about the connection of CE to the strategic development of a sustainable society.

**Actions**

The actions level comprises the actions that build the path from the current reality towards the success state (Broman and Robèrt 2017, 22). When this state is defined as a sustainable society, this includes all actions that are carried out within the boundary conditions and move the socio-ecological system to such a society. For our research, the specific projects that cities have implemented toward CE can be placed in the action level.

**Tools**

The tools level collects methods that support the implementation of actions to move towards the defined success (Broman and Robèrt 2017, 22). For the purposes of this research, we will be viewing the concept of CE itself as a tool to support sustainability, which can be applied on a variety of scales (e.g. industry, supply chain, city).

### 2.3 Summary of Research Methods

In addition to an overall pragmatic approach and using the FSSD as a lens for the research, each of the three research steps have their own data collection and analysis methods. The methods, per research step, are summarized in Table 2.1 and further elaborated in this subchapter.

**Table 2.1: Summarized Research Methods.**

<table>
<thead>
<tr>
<th>Research Steps</th>
<th>Data Collection Method</th>
<th>Data Analysis Method</th>
</tr>
</thead>
</table>
| Step 1: CE definition analysis | • Interviews  
• Documents | • Thematic Analysis |
| Step 2: Overview of CE actions in cities | • Interviews  
• Documents | • Classic Content Analysis |
| Step 3: SSD assessment of CE actions | • Data collected in Step 2 | • FSSD-Assessment |
2.4 Methods for Step 1: Circular Economy Definition Analysis

2.4.1 Data Collection: Interviews and Documents

We collected a total 35 definitions from a variety of organizations (Table 2.2; Appendix A: detailed overview). In order to get an overview of the definition that is being used in practice, we used both documents and interviews as sources.

Table 2.2: Overview of Definition Sources.

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cities &amp; Regions</td>
<td>18</td>
</tr>
<tr>
<td>CE Consultancy</td>
<td>7</td>
</tr>
<tr>
<td>NGO</td>
<td>5</td>
</tr>
<tr>
<td>Governmental Body</td>
<td>2</td>
</tr>
<tr>
<td>Educational Institutions</td>
<td>2</td>
</tr>
<tr>
<td>Academic Article</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>

Documents

Different types of documentation was collected to gain an understanding of the definitions of CE being used in the field. In order to ensure that our sources embodied the holistic nature of the concept, we also looked at several institutional definitions, and consultancy organizations who work with CE. One academic source was chosen; a review paper on CE by Geissdoerfer et al. (2017). This review paper provided a synthesis of other CE definitions in literature. Much of the data was found through online searches. A sample of the keyword search terms are: ‘circular economy’, ‘circular economy consultancy’, ‘circular city’, ‘circular economy vision’, and ‘circular economy definition’ and ‘circular economy university definition’ and ‘circular economy NGO’. Online searches were also specifically directed at large governmental bodies (e.g. World Economic Forum, EU), in order to get insight on if they used a CE definition.

Interviews

Documentation was supplemented with interviews with municipalities working with CE. A total of 34 municipalities were contacted by email. Eventually, we conducted 17\(^1\) semi-structured interviews with municipalities actively working with CE, typically lasting around 60 minutes. We also conducted five written interviews (Appendix B: list of cities and interviewees). The interviews were focused on two main themes providing information for

\(^1\) The number refers to the total number of interviews for the first and second research steps.
both the first and the second step of our research: a definition of CE, and implemented CE actions in the city.

To find the interviewees, a mixture of concept- and network-sampling was used. With the concept sampling method, we identified flagship CE projects around the world, and cities that are pioneering in CE. These projects and cities were found through CE networks like: Circular Cities Network from EMF, ACR+, Circular Europe Network, De Groene Zaak and the C40 Cities Climate Leadership Group. We used governmental website such as the Environmental Protection Agency in the USA to gain insights on listed case studies in cities and states around the United States. While not all searches were successful, sample keywords to find cities and projects around CE were: ‘circular economy’, ‘circular economy cities’, ‘circular economy municipalities’, ‘circular economy in cities’, ‘circular economy in municipalities’, ‘circular economy europe’, ‘circular economy united states’, ‘circular economy south america’, ‘circular economy canada’, ‘circular economy india’, ‘circular economy southeast asia’, ‘circular economy malaysia’, ‘circular economy singapore’, ‘circular economy indonesia’, ‘circular economy africa’.

Our search also included case studies of the pioneering CE countries that were mentioned in the literature review on CE: Japan, China and Germany. Some additional searches were done to find more on these countries, with keywords like: ‘circular economy China’, ‘circular industrial park China’, ‘industrial symbiosis China’, ‘circular economy japan’, ‘circular economy Tokyo’, ‘biomass towns Japan’, ‘circular economy Germany’, ‘Circular Economy Deutschland’, ‘Kreislaufwirtschaft Deutschland’.

The interview parts regarding the definition of CE were structured to ensure standardized results. Due to geographical and budget limitations, our interviews were conducted solely using communication methods like Skype, Google Hangout, telephone or in the case of five interviews, via email. Interviews were recorded and transcribed to preserve the original nuances in the statements of the interviewee. The transcriptions of these interviews also allowed for later reflection and reflexivity regarding the influence of personal experience on analysis of the data, and for peer consultation and review to check for potential bias (Berger 2015, 230).

2.4.2 Data Analysis: Thematic Analysis

Thematic analysis was used to analyze the data from this research question. Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data (Braun and Clark 2006). The flexibility of this method allows for systematic analysis, while leaving space for our intuition to guide us through the connections and themes that we found. Open coding was used in order to allow for emergent patterns and avoid predictive results.
The following steps were taken to synthesize a definition:

1. Familiarized ourselves with the data by reading through the definitions and formatting them in uniform sample pieces based on the capture of ideas.
2. Pulled out the keywords from each line, resulting in 256 lines of keywords.
3. Generated initial, broad category codes (open coding) based on the keywords, and allocated those codes as they reoccurred.
4. Generated subcodes by identifying and understanding the underlying themes of each sample piece, and in the context of their category code.
5. Reviewed category codes and subcodes, editing for consistency and clarity where necessary.
6. Assessed the connections between category codes and subcodes by checking the content of the code clusters.
7. Assessed category codes on whether they provided a general description of CE, or if they were more specific about a particular aspect and could be formed into its own principle.
8. Synthesized descriptions of category codes, using their subcodes.
9. Synthesized these descriptions into one overarching definition and nine descriptive principles.

(based on Savin-Baden and Major 2013, 440).

### 2.5 Methods for Step 2: Overview of Circular Economy Actions

#### 2.5.1 Data Collection: Interviews and Documents

We used the interviews from the first research step as our main source to also collect the information about which actions cities have taken to integrate CE. This decision was made because interviews can provide detailed and up-to-date insights and understanding about actions cities have taken. As outlined under the methods for the first research step, we conducted 16 interviews via online communication (i.e. Skype), five written interviews, and one in-person interview to receive this information. Information about actions from one further city were collected on the basis of published documents only (Appendix B: Cities and Interviews Included in the Research). Where necessary, the interviews were complemented by published information to enhance the credibility of the information on certain actions, and counter potential interviewee bias.

As already described under the methods for the first research step, a mixture of concept- and network-sampling has been used to find the interviewees. The interview sections concentrating on actions were semi-structured in order to maintain consistency of information between interviews while allowing for flexibility based on the emergent discussion. These interviews were recorded and transcribed as well. Interviews added a layer of dialogic
reasoning to the research, where contradictions between documentation and reality could be identified.

2.5.2 Data Analysis: Classic Content Analysis

A classic content analysis was conducted in order to produce qualitative descriptions of the content of the documents and interview transcripts in a systematic and objective way (Berelson 1952, 489). The classic content analysis as a description-focused method was chosen to concentrate on the content with little interpretation.

The steps of this analysis were as follows:

1. Examined the interview transcript by making sense of what was said.
2. Systematically searched for all actions or initiatives a municipality identified as supporting the field of CE.
3. Extracted the identified actions and crafted a solid description with the help of additional documents (if necessary).
4. Determined rules for categorizing and mapped the actions regarding their type.
5. Allocated category codes and subcodes to categorize the actions.
   - Reviewed category codes and subcodes, adding where necessary.
   - Assessed the connections between category codes and subcodes.
   - Reviewed and finalized a total of 12 category codes and 22 subcodes.
6. Analyzed the frequencies of category codes and subcodes from different angles in order to identify themes around the actions.

(adapted from Savin-Baden and Major 2013, 438)

A final step that was undertaken after the finalized category codes and subcodes for the actions, was to compare the actions to the definition that was synthesized in our first research step. For this, every action was matched to one or more of the nine CE principles, or as a general CE enabler. With this information we were then able to compare the theoretical definition to the practical CE actions.

2.6 Methods for Step 3: SSD Assessment of Circular Economy Actions

2.6.1 Data Collection

The data used for this step was collected in Step 2, in which an overview of CE actions was generated using interviews and documents.
2.6.2 Data Analysis: Using the FSSD

The assessment of the implemented CE actions in cities had its foundation in the FSSD. The steps of the assessment were as follows:

1. Adapted the 8SPs of the FSSD into questions appropriate to the context of CE in cities (adaptation described in detail below).
2. Adapted the generic prioritization questions of the FSSD to the context of CE in cities by formulating strategic assessment questions (adaptation described in detail below).
3. Standardized our assessment by first collecting the inputs/inflow and outputs/outflows of each action after general boundaries for the scope were set.
4. Used deductive reasoning to assess the action against the eight sustainability questions, and the strategic questions developed in step one and two of the procedure.
5. Reviewed actions and their assessment for consistency and validity.
6. Requested or researched additional information from interviewees when key information was missing.

As the first step of the data analysis process mentions, the 8SPs were transferred into questions in order to enable the assessment. The questions for the SPs 1-3 were phrased as:

“Does the action/policy/platform contribute to systematically increasing…

… concentrations of substances extracted from the earth's crust in nature?

… concentrations of substances produced by society in nature?

… degradation by physical means in nature?”

With regard to the SPs 4-8 the actions were assessed by the questions:

“Does the action/policy/platform create or maintain structural obstacles to people's…

… health?

… influence?

… competence?

… impartiality?

… meaning-making?”

(adapted from Broman and Robèrt 2017, 23).

As the second step, the generic prioritization questions of the FSSD were adapted to the context of this research and transformed to assessment questions. The first original question was taken out, as the ‘right direction’ was determined by the 8SPs. The third question was adapted and broken up into: ‘potential for financial savings or revenues’, and the ‘potential positive impact on the citizens of a city’. This then ultimately concluded to the following 3 questions:

1. “Does this action provide a stepping stone for further actions that contribute to the development towards a sustainable society?”

2. “Does this action provide the municipality with potential financial savings or revenues?”

3. “Is this action likely to produce direct or indirect positive impact on the citizens of the city?”

(adapted from Robèrt et al. 2015, 44).
3 Results

This chapter outlines the results for the three main research steps. First, the results will be presented on the definition analysis of CE in the context of cities. Second, the results on CE actions in cities will be shown, providing the current reality. And lastly, the results of the FSSD assessment of these actions are shown.

3.1 Step 1: Definition Analysis of Circular Economy

This subchapter outlines the findings of the definition of CE, by showing an overview of the different categories and their subcodes that emerged. Each category is explained and examples are given to provide more context. An outlier definition is highlighted, and the most recurring definition that cities are using is elaborated on.

3.1.1 Definition Categories and Frequencies

A mixed method data collection approach concluded 35 definitions of CE, 18 of which originate from municipalities. After extensive thematic coding of these definitions, 18 overarching categories emerged. Table 3.1 presents the frequencies of these categories, with the total amount representing the code lines. There are seven municipalities we interviewed that did not have a working definition.

The most common categories and their frequencies include ‘Human Society’ (30), ‘Intentional Design’ (44), and ‘Waste as Resource’ (78). The least common themes are ‘Ecological System’ (4) and ‘Resilient & Adaptive’ (5). Chapter 3.2.2 will elaborate on the categories and their subcodes.

Table 3.1: Definition Categories and Frequencies.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Category</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste as Resource</td>
<td>78</td>
<td>No Definition</td>
<td>7</td>
</tr>
<tr>
<td>Intentional Design</td>
<td>44</td>
<td>Biological Cycle</td>
<td>7</td>
</tr>
<tr>
<td>Human Society</td>
<td>30</td>
<td>Resilient &amp; Adaptive</td>
<td>5</td>
</tr>
<tr>
<td>Business Model</td>
<td>15</td>
<td>Model Description</td>
<td>5</td>
</tr>
<tr>
<td>Restore and Regenerate</td>
<td>12</td>
<td>EMF</td>
<td>5</td>
</tr>
<tr>
<td>Generate Value</td>
<td>11</td>
<td>Principle-driven</td>
<td>4</td>
</tr>
<tr>
<td>Cycle</td>
<td>10</td>
<td>Ecological System</td>
<td>4</td>
</tr>
<tr>
<td>Energy</td>
<td>8</td>
<td>Systems Perspective</td>
<td>2</td>
</tr>
<tr>
<td>Technical Cycle</td>
<td>7</td>
<td>Non Human Species</td>
<td>1</td>
</tr>
</tbody>
</table>
3.1.2 Category Descriptions

The following subchapter discusses the findings per category, using the frequencies of subcodes and examples of excerpts of definitions.

1. Waste as a Resource

The most frequent category that emerged from the definition analysis, with 78 counts, is ‘Waste as Resource’. Most recurring subcodes under that category were ‘Recycle’ (16), ‘Upcycle’ (15), ‘Reduce’ (8), and ‘No Waste’ (6). The following excerpts are examples of this theme used within the definition:

Freiburg, Germany: “Circular Economy tries to maintain the value of products as long as possible, preserve natural resources and eliminates waste with focusing on prevention, reuse and recycling” (Sawatzki 2017).

Gothenburg, Sweden: “Talking more about resources than waste” (Wolf 2017).

Kitakyushu, Japan: "Using all waste as material for other industries, Reducing waste as much as possible (zero emission), Fostering a resource recycling society" (Arima 2017).

2. Intentional Design

With 44 counts, ‘Intentional Design’ was the second most recurring category in the definition analysis. With the intentional design both applied to the system as a whole or specifically focused on a product. Most recurring subcodes in this category are ‘Recycle’ (8), ‘Upcycle’ (8), and ‘Ecology’ (6). The following excerpt is an example of this theme used within the definition:

Amsterdam, The Netherlands: “Modular and flexible product design and supply chains will increase the adaptability of systems” (Circle Economy 2016, 9).

Vancouver, Canada: “Achieving a true circular economy hinges on ... designers that are consciously designing for deconstruction or reuse” (Vancouver Economic Commission 2017a).

3. Human Society

Within the category of ‘Human Society’ there was a heavy emphasis on ‘Collaboration’ (7). The subcode ‘Social Sustainability’ (5) emerged and included definitions that touched upon elements of health, wellbeing, and equality of society. ‘Economic Development’ (4) and

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2 The category ‘Human Society’ was generated using a nested systems approach, in which the economic system is nested in the larger human society system. This is due to the overarching FSSD perspective that was taken with this research.
‘Economic Opportunity’ (3) were also elements that were mentioned in the definitions collected. The following excerpts are an example of this theme used within the definition:

New York, USA: “We are in a political and economic climate that puts jobs, equity, and relationship building at the center of what we do. Finding ways to support circular economy thinking in New York City can definitely help us achieve these goals. We’re very much seeing this through the lens of economic development” (Kalule-Sabiti 2017).

Baltimore, USA: “[...] we are trying to find ways to ensure that we are creating economic opportunities for citizens in Baltimore through diverting these different waste streams. The three streams that we work on specifically are wood waste, construction demolition debris [...] and food waste” (Cook 2017).

4. Business Models
A total of 15 definitions emphasized the need for business models in describing CE, six of those related to ‘Innovation’ within business models. The following excerpt is an example of this theme used within the definition:

Amsterdam, The Netherlands: “Transition from possession to use of services; this will require new business models for production, distribution and consumption” (Circle Economy 2016, 9).

5. Restore and Regenerate
There are 12 definitions that fit into a ‘Restore and Regenerate’ theme, speaking both from an ecological and economical perspective. ‘Restore’, ‘Regenerate’, or ‘Restore and Regenerate’ were mentioned six times. The following excerpts are an example of this theme used within the definition:

“A circular economy is an industrial system that is restorative or regenerative by intention and design” (World Economic Forum 2014).

“It stands from the basis that our systems should work like organisms, processing nutrients that can be fed back into the cycle, hence the “restorative” term used” (Circular Economy Club 2016).

6. Generate Value
There were 11 occurrences in which a definition was categorized under ‘Generating Value’. This was expressed using words like ‘Efficiency’ (3), ‘Growth’ (2), and ‘Natural Capital’ (2). The following excerpts show how this theme is used within the definition:
“They keep resources within the economy when a product has reached the end of its life, so that they can be productively used again and again and hence create further value” (European Commission 2015).

“These cycles maximize retention of economic value” (CSR Netherlands 2015).

Amsterdam, The Netherlands: “Natural resources will be used to generate new financial or non-financial gains” (Circle Economy 2016, 9).

7. Energy
There were eight occurrences in which definitions were categorized under ‘Energy’, with only two subcodes, referring to either ‘Renewable’ (6) and ‘Reduce’ (2).

8. Resilient & Adaptive
There were five occurrences in which definitions were categorized under ‘Resilient & Adaptive’, with definitions describing ‘Resilience’ (2), ‘Resilient & Adaptive’ (1), speaking to ‘increasing the adaptability of systems as a whole’ (1), and ‘minimizing system risks’ (1)

“The economic system is inherently adaptable and resilient” (Metabolic 2017).

9. Ecological System
Four definitions touched upon the preservation of the ecological system by mentioning either ‘Mitigation’ (1), ‘Biodiversity’ (1), ‘Non Toxic’ (1), or ‘Efficiency’ (1).

“A circular economy [...] eliminates the use of toxic chemicals, which impair reuse and return to the biosphere” (World Economic Forum 2014).

Freiburg, Germany: “Circular Economy tries to [...] preserve natural resources” (Sawatzki 2017).

3.1.3 Synthesized Definition
The categories of ‘principle driven’ (4), ‘model description’ (5), ‘systems perspective’ (2), ‘technical cycle’ (7), ‘biological cycle’ (7), and cycle’ (10) were all incorporated into an overarching general description of the system. The remaining nine categories, as described in the previous subchapter, were phrased into individual principles, using the frequency of subcategories. A definition of CE for the context of cities was synthesized as follows:

Circular economy is a model that looks at human society from a system’s perspective, where both technical cycles (using innovation to close the loop for materials and products), and biological cycles (the cycle of organic material and nutrients) are recognized. Preference is given for cycles that are being closed on a local scale for both.
The following nine principles show the different enabling aspects of this model:

1. Waste is a resource, and therefore materials are efficiently recycled and upcycled to maintain their highest value for as long as possible.
2. Design is intentional. Systems have a service-based preference and materials are designed for recycling, upcycling, and longevity.
3. Social sustainability is enhanced through sharing and collaboration while simultaneously stimulating economic development and opportunities.
4. Innovative business models are used as an enabling tool.
5. Systems take inspiration from ecology and living systems, where both materials and nutrients are cycled to restore and regenerate the economic and ecological system.
6. Both financial and natural capital are recognized and new value is generated through the cycling and restoration of materials.
7. Energy usage is reduced and comes from renewable sources.
8. The system is designed to be both resilient and adaptive through flexible design, diversification, and risk mitigation.
9. The ecological system is preserved by supporting biodiversity, eliminating toxic materials and managing externalities.

3.1.4 Outlier Definitions

While there were many recurring categories that were used to create the above synthesized definition, there was also an outlier category with only one definition which mentioned non-human species. An excerpt of that definition states the following:

“The health and wellbeing of humans and other species are structurally supported” (Metabolic 2017, 79).

3.1.5 Most Recurring Definition

It is worth noting that five municipalities that were interviewed are using the definition of EMF which states the following:

“The concept is characterised, more than defined, as an economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. It is conceived as a continuous positive development cycle that preserves and enhances natural capital, optimises resource
yields, and minimises system risks by managing finite stocks and renewable flows. It works effectively at every scale. This economic model seeks to ultimately decouple global economic development from finite resource consumption” (Ellen MacArthur Foundation 2015, 5). With three additional principles on preserving and enhancing natural capital, optimising resource yields, and fostering system effectiveness (ibid.).

Julia Vol (2017), a portfolio manager from EMF, describes CE as an economic model which designs out waste from our economic system, and therefore as an end state. She adds however, that “it’s informing a lot of the processes as well. Because it’s an unfolding definition and concept, we keep learning new things about it, and I think that in a way it’s both a process and an end goal. I think it’s very hard to decouple one from the other” (ibid.).

3.2 Step 2: Circular Economy Actions in Cities

This subchapter provides the results of all the CE actions that were gathered, providing an overview of the categories and sub codes that emerged, along with some examples of actions. Results will also show how the actions overlap with our synthesized definition of CE.

3.2.1 Total Amount of Actions and Their Category Frequencies

From the 21 cities examined we identified 87 actions that are implemented in cities to enable CE. To see how the actions are distributed amongst the cities, consult Appendix C. For a full overview of all the actions see Appendix D. The types of actions are spread amongst 12 categories describing the way the actions support CE (Table 3.2). The most frequently occurring categories are ‘Collaboration’ (15), ‘Business’ (12), ‘Platform’ (9) and ‘Policy’ (9).

<table>
<thead>
<tr>
<th>Code</th>
<th>Frequency</th>
<th>Code</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>15</td>
<td>Facilities</td>
<td>5</td>
</tr>
<tr>
<td>Business</td>
<td>12</td>
<td>Fund</td>
<td>5</td>
</tr>
<tr>
<td>Platform</td>
<td>9</td>
<td>Incubator</td>
<td>5</td>
</tr>
<tr>
<td>Policy</td>
<td>9</td>
<td>Research</td>
<td>5</td>
</tr>
<tr>
<td>Ambition</td>
<td>7</td>
<td>Technology</td>
<td>5</td>
</tr>
<tr>
<td>Communication</td>
<td>6</td>
<td>Urban Development</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>87</td>
</tr>
</tbody>
</table>
3.2.2 Subcode Frequencies

In our CE action analysis, we identified a total of 22 different subcodes with diverse frequencies (Appendix E). The subcodes represent a field or area where an action takes place. The most frequent subcodes were ‘Innovation’ (12), ‘Business’ (12), and ‘Material Use’ (9), followed by ‘Network’ (6) and ‘Waste Separation’ (6).

3.2.3 Category Compositions

The following subchapter describes the categories of actions, guided by their frequency and their subcodes. Examples of actions are used to further elaborate.

Collaboration

The action type ‘Collaboration’ occurred most frequently in our analysis (15). The areas of implementation under this category are ‘Business’ (7), ‘Network’ (6), ‘Research’ (1) and ‘Community’ (1). This category covers the direct collaboration of the municipality with others but also actions that are an enabler for others to build partnerships among one another around CE. The main focus of these actions is the collaboration itself.

An example of direct collaboration is membership of the EMF Circular Cities Network. Five cities in our research are part of this network: Austin, New York, Peterborough, Phoenix, and Vancouver (Ellen MacArthur Foundation 2017a). The producer partnership of the municipality of Oslo with plastic producers serves as an example of collaboration with business. The purpose of this program is:

“To identify what criteria the industry uses when developing new plastic packaging and whether recyclability could be integrated into that criteria. The purpose of the program is less to influence the industry, and more to develop a shared understanding of the various levels of the value chain” (Jentoft 2017).

Another example of this category is the Circular Peterborough Commitment:

“The Circular Peterborough Commitment is all about engaging businesses and even individuals, and getting them to pledge their support to our co-created vision of what a circular city is” (Thomas 2017).

As part of the commitment, the city has developed seven pillars to act (rethink; redesign; repurpose, reuse & share; repair; remanufacture; recycle; recover). It is open for engagement from both businesses and individuals (Opportunity Peterborough 2017, 4-5).
**Business**

The second-most action type is ‘Business’ (12). This category is split up into the areas ‘Material Use’ (8), ‘Innovation’ (3), and ‘Energy’ (1). It contains businesses that the municipality directly operates, closely supports or works together with.

One example of direct business involvement in the field of material use is Camp Small in Baltimore. The idea behind Camp Small is to collect municipal wood waste, sort it and sell it again as different products (Tree Baltimore 2017). Andrew Cook from the office of sustainability in Baltimore describes the intention behind the program as follows:

> “What we did was to come up with a plan for how we could better manage this material, recognizing that there was value in this material. Logs that were coming in there could be milled for lumber, some of the smaller logs had value as firewood or could be turned into biomass in the form of wood chips to generate energy” (Cook 2017).

Another example for an action in the field of business is BroodNodig in Rotterdam. In this case, the municipality is not directly involved in the business, but provides financial support and advice. The organization collects bread in separated bins around the city to produce biogas from it (BroodNodig 2017). At the same time, the municipality sees how the businesses’ operation could solve a problem somewhere else: “People throw bread into the water for the ducks, but the rats eat it, so it’s a big problem” (Berger 2017).

**Platform**

The third most frequent action type identified is ‘Platform’ (9). This category contains the subcategories ‘Material Relaying’ (3), ‘Innovation’ (2), ‘Label’ (2), ‘Research’ (1), and ‘Sharing’ (1). Actions under these areas predominantly provide space for others to act.

An example for a platform in the field of sharing is the Share Peterborough Platform. This platform enables businesses to share leftover material, skills, space and facilities. The municipality facilitates the platform and also conducted workshops to educate businesses on how to make best use of it (Thomas 2017).

Another example is a municipality-internal furniture management platform. This platform is implemented in Eskilstuna and in a similar way in Gothenburg. An online system is used, where furniture from different municipal buildings can be circulated between facilities as needed, providing savings in procurement through reuse (Vilkuna 2017).

**Policy**

The action category of ‘Platform’ has the same frequency as ‘Policy’ (9). It includes policies that support CE directly or indirectly. The actions under this category address multiple areas: ‘Construction’ (2), ‘Material Ban’ (2), ‘Behavior’ (1), ‘Contracting’ (1), ‘Organic Waste Use’ (1), ‘Procurement’ (1), and ‘Waste Separation’ (1).
In Vancouver, there is a policy that requires the deconstruction instead of demolition of certain house types. It requires 80% of the material to be diverted by the deconstruction company (Basilij 2017).

There are also direct bans for certain material. One example is the expanded polystyrene foam (EPS) ban in San Francisco. EPS is often used for food containers, cups and other packaging. Restaurants, food service providers, as well as markets and retailers in San Francisco are not allowed to put that material into circulation (Chiv 2017).

In Apeldoorn, there are attempts to rethink their approach to tendering all together. For a sustainable urban development project called ‘De Parken’, they are currently tendering for a contractor as a partner in the project, rather than contracting them for a specific part of the development. Creativity and commitment to CE are requirements for this contract, with the aim to find the most innovative business and work with them as a partner in this development (Lubberhuizen and Veenhuizen 2017).

**Ambition**

The action type ‘Ambition’ (7) follows the top four categories of the analysis. It is split up into ‘Waste (in general)’ (4) and ‘Procurement’ (3) and includes commitment of municipalities to reach a certain goal connected to CE.

Four municipalities in our research, Austin, Phoenix, San Francisco, and Vancouver set a zero waste goal. Three of the municipalities interviewed, Amsterdam, Haarlemmermeer, and Rotterdam, signed a national manifesto for socially responsible procurement (Pianoo 2017).

**Communication**

Six actions can be categorized under the term ‘Communication’. The category is composed of the areas ‘Waste Separation’ (4), ‘Innovation’ (1), and ‘Material Use’ (1).

Communication for ‘Waste Separation’ can best be described as community education or engagement campaigns. An example for that type of action is the program “Winst uit je Afval” (profit from your waste) in Haarlemmermeer. The program aims to show people the value of waste and the importance of waste separation by testing different collection methods in certain neighborhoods (Gemeente Haarlemmermeer 2017).

**Incubator**

Another type of action that emerged in the analysis is ‘Incubator’ (5). The incubators discovered in the research provide space to startups to develop and prototype new solutions that may fit into a circular economy. Therefore, the actions are all sub-categorized in the field of ‘Innovation’.
One example of a program to support an entrepreneurial ecosystem is Urbantech NYC. The program supports “the emergence, development and maintenance of three incubation, private studio, and co-working spaces for startups and early growth stage companies working to solve urban challenges across many sectors from energy to digital infrastructure.” The city provides funding and also has contractual relationships with the operators (Kalule-Sabiti 2017).

Research

The category ‘Research’ also came up five times. It is divided into the areas ‘Flows’ (3), ‘Innovation’ (1), and ‘Technology’ (1). The category describes actions that aim to increase knowledge at the municipality in order to approach CE.

An example of research in ‘Flows’ is the circle scan that was commissioned by Amsterdam. The process included a mapping of the material and energy flows, an analysis of value chains, and the development of a vision and roadmap (Circle Economy 2016, 4).

Funds

‘Funds’ are another type of category occurring in our analysis (5). Following our observations, funds from municipalities are provided for the purpose of ‘Business’ (4) and ‘Research’ (1).

One example is the Meermaker fund in Haarlemmermeer, which focuses on regional and sustainable solutions: “What they do is they give to startups with good ideas, who don’t get funding on the regular market, they get credits for upscaling” (Tuinstra and Ruis 2017).

Technology

Another category of action that emerged in the analysis is ‘Technology’ (5). The category contains the subcodes ‘Organic Waste Use’ (4) and ‘Energy’ (1).

An example for the use of technology to implement CE is the biogas generation in Oslo. “We have separate sources separations systems for food waste and it’s brought to a biogas plant which produces biogas which is then used by busses and waste trucks within the city, and the fertilizer is used by farmers around the biogas plant” (Jentoft 2017).

Facilities

‘Facilities’ (5) is another category for CE actions. This category describes actions relating to when municipalities build or provide facilities that support CE. Different areas are ‘Sharing’ (2), ‘Education’ (1), ‘Research’ (1), and ‘Waste Separation’ (1).

An example for a sharing facility is the Baltimore Community Toolbank in Baltimore. It is “a place where nonprofits can go and borrow tools for free to do projects around this city” (Cook 2017).
Urban Development

The least frequent action category that emerged in our research is ‘Urban Development’ (4). It is specified by the subcodes ‘Housing’ (3) and ‘Business’ (1). The actions within these categories deal with the development of urban areas linked to the idea of CE.

Circular Buiksloterham in Amsterdam is an example for the development of a whole neighborhood incorporating CE. Buiksloterham as a former industrial zone is being developed “into a sustainable and circular district” (Amsterdam Smart City 2016).

3.2.4 Overlap with the Definition of Circular Economy

We also evaluated the overlap between the CE actions in cities and the synthesized definition of our first research step (see Table 3.3). This was done by matching them to the overarching definition (‘General Enabler’, ‘Closing the Technical Cycle’, and ‘Closing the Biological Cycle’), and against the nine principles. Actions generally addressed multiple parts of the definition.

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Enabler</td>
<td>68</td>
<td>78.2%</td>
</tr>
<tr>
<td>Waste as a Resource</td>
<td>42</td>
<td>48.3%</td>
</tr>
<tr>
<td>Intentional Design</td>
<td>25</td>
<td>28.7%</td>
</tr>
<tr>
<td>Human Society</td>
<td>25</td>
<td>28.7%</td>
</tr>
<tr>
<td>Business Models</td>
<td>20</td>
<td>23.0%</td>
</tr>
<tr>
<td>Generate Value</td>
<td>13</td>
<td>14.9%</td>
</tr>
<tr>
<td>Energy</td>
<td>10</td>
<td>11.5%</td>
</tr>
<tr>
<td>Restore &amp; Regenerate</td>
<td>9</td>
<td>10.3%</td>
</tr>
<tr>
<td>Ecological System</td>
<td>8</td>
<td>9.2%</td>
</tr>
<tr>
<td>Closing the Technical Cycle</td>
<td>6</td>
<td>6.9%</td>
</tr>
<tr>
<td>Closing the Biological Cycle</td>
<td>5</td>
<td>5.7%</td>
</tr>
<tr>
<td>Resilient &amp; Adaptive</td>
<td>2</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

The results show that the majority of the actions contribute to CE as a ‘General Enabler’ (78.2%). Almost half of the actions correspond to the understanding of ‘Waste as a Resource’ (48.3%). The third most overlapping categories are both ‘Intentional Design’ and ‘Human Society’ (both 28.7%), followed by ‘Business Models’ (23%). The least actions correlate with ‘Resilient & Adaptive’ (2.3%). Furthermore, only a small amount of actions (6.9% and 5.7%) can be linked to the overarching themes ‘Technical Cycle’ and ‘Biological Cycle’.
3.3 Step 3: Strategic Sustainable Development Assessment

This chapter shows the results of our third research step, in which we assessed the CE actions found from the second research step. First, we discuss the results of our sustainability analysis of the 8SPs, and then we discuss the results of the assessment using the three strategic questions. Lastly, we look at the categories in which misalignments took place, to better understand the full picture.

3.3.1 Sustainable Development

Using the 8SPs as described in the methods, every action was assessed with the information given by the interviewee, and supplemented by online documents. Each action was assessed for its violations of the 8SPs. The specific questions are described in Chapter 2.6.1. The possible answers were either ‘Yes’, ‘No’, or ‘Precautionary Yes’. Meaning that ‘Yes’ is a misalignment, and ‘No’ that the assessed action is within the boundary of the principle. ‘Precautionary Yes’ was given when there was not enough information to make the assessment that it was not contributing.

For each SP, the results can be seen in Figure 3.1. The SP misalignment frequencies are as follows: SP1 (4 Yes, 8 Precautionary Yes), SP2 (2 Precautionary Yes), SP3 (5 Precautionary Yes), SP4 (4 Precautionary Yes), and SP 5 (1 Yes, 4 Precautionary Yes), SP6 (0), SP7 (1 Yes, 2 Precautionary Yes), SP8 (1 Precautionary Yes).

![Figure 3.1: Sustainability Principle Analysis of Actions.](image-url)
3.3.2 Strategic Approach

In order to assess whether or not the actions are strategic towards sustainable development, the SP analysis was supplemented by three questions regarding their strategic approach. The three strategic guideline questions (SG 1-3) used to assess the strategic direction of each action, and how they were developed was described in Chapter 2.6.1. The possible answers were ‘Yes’, ‘No’, and ‘Unsure’, where ‘Yes’ means that an action aligns with a strategic orientation and ‘No’ means a misalignment. The terms ‘Unclear’ or ‘Unsure’ were assigned when the question could not be answered, due to missing information that could not be verified by interviewees or documents. Table 3.4 shows the results of these questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Unsure/Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG 1</td>
<td>85</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SG 2</td>
<td>31</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>SG 3</td>
<td>66</td>
<td>16</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 3.4: Answers to the Three Strategic Guideline Questions.

SG 1: Does this action provide a stepping stone for further actions that contribute to the development towards a sustainable society?
Almost all actions (97.7%) provided a stepping stone for further actions that contribute to the development towards a sustainable society. This was due to the fact that the action contributed to building partnerships (49.4%), stimulated new business or markets (47.1%), or that it increased internal awareness of the municipality (39.1%). See Table 3.5 for the full overview.

Table 3.5: Potential Contributions to Other Actions (SG1).

<table>
<thead>
<tr>
<th>Area of contribution</th>
<th>% of actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build Partnerships</td>
<td>49.4%</td>
</tr>
<tr>
<td>Stimulates New Business or Market</td>
<td>47.1%</td>
</tr>
<tr>
<td>Increase Internal Awareness</td>
<td>39.1%</td>
</tr>
<tr>
<td>Increase External Awareness</td>
<td>31.0%</td>
</tr>
<tr>
<td>Stimulates Recycling</td>
<td>27.6%</td>
</tr>
<tr>
<td>Direct Material Use</td>
<td>21.8%</td>
</tr>
<tr>
<td>Provide an example</td>
<td>17.2%</td>
</tr>
</tbody>
</table>
SG2: Does this action provide the municipality with potential financial savings or revenues?
The largest share of the actions (37.9%) could not provide potential financial savings or revenues. Almost the same share (35.6%) however, was assessed with ‘Yes’ to this question, while for 26.4% of the actions it was ‘Unclear/Unsure’.

SG3: Is this action likely to produce direct or indirect positive impact on the citizens of the city?
Of all the actions, 75.9% of them were determined to produce direct or indirect positive impact on the citizens. This was due to reasons like: the ability to get engaged in the action, access to new materials, education opportunities, and employment opportunities. There were also some actions (18.4%) that answered ‘No’ to this question, and 5.7% of actions were categorized as ‘Unsure/Unclear’. In all instances where ‘No’ was answered, it was because it benefited the municipality or businesses, and not the citizens.

3.3.3 Category Trends with Misalignments

Sustainability Misalignment Trends
Most sustainability misalignments within the actions, with four ‘Yes’ and eight ‘Precautionary Yes’, occurred with the first SP: In a sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the Earth’s crust.

These misalignments occurred in the following categories:

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>Energy</td>
<td>1</td>
</tr>
<tr>
<td>Business</td>
<td>Material Use</td>
<td>5</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Business</td>
<td>1</td>
</tr>
<tr>
<td>Facilities</td>
<td>Research</td>
<td>1</td>
</tr>
<tr>
<td>Incubator</td>
<td>Innovation</td>
<td>2</td>
</tr>
<tr>
<td>Policy</td>
<td>Waste Separation</td>
<td>1</td>
</tr>
<tr>
<td>Technology</td>
<td>Organic Waste Use</td>
<td>1</td>
</tr>
</tbody>
</table>

These results show that the most frequent category is ‘Business’ (6), and the most common subcategory ‘Material Use’ (5). The misalignments are all due to dependency on nonrenewable energy. An example of this is Camp Small. This wood waste collection yard is an initiative started by the Baltimore City Department of Recreation and Parks. Municipal wood waste from the department is being processed into Compost, Wood Chips, Log Seconds, Brush Waste Logs to be resold to the community. While the facility’s main purpose
of recycling wood waste back into the community is aligned with the SPs, the equipment used for processing is still dependent on nonrenewable fuel (Tree Baltimore 2017).

**Strategy misalignments**

Out of the three questions surrounding the actions’ strategic approach SG2 (*Does this action provide the municipality with potential financial savings or revenues?*) had the most actions that were ‘No’ (33 actions / 39.7%). Table 3.7 shows the most frequent categories for these actions. This means that these actions could not provide potential financial savings or revenues. By far, the ‘Collaboration’ category was the most frequent, with 12 counts, followed by ‘Research’ (4) and ‘Policy’ (4).

Table 3.7: Strategic Misalignments for SG2 per Category.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency of 'No'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>12</td>
</tr>
<tr>
<td>Research</td>
<td>4</td>
</tr>
<tr>
<td>Policy</td>
<td>4</td>
</tr>
<tr>
<td>Facilities</td>
<td>3</td>
</tr>
<tr>
<td>Urban Development</td>
<td>2</td>
</tr>
<tr>
<td>Platform</td>
<td>2</td>
</tr>
<tr>
<td>Fund</td>
<td>2</td>
</tr>
<tr>
<td>Communication</td>
<td>2</td>
</tr>
<tr>
<td>Business</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>
4 Discussion

This chapter will interpret and discuss key findings. A recommendation subchapter supplements these insights with recommendations for municipalities on how they might use their unique position to stimulate CE in their city. The chapter also touches upon the strengths and limitations of the research, and ultimately recommends further research.

4.1 Circular Economy Definition

This subchapter discusses the findings from research step one, using the results, previous literature introduced in chapter 1, and additional insights.

4.1.1 A Lack of Consistent Circular Economy Definition

Our findings from research step one showed that the scope of the definitions for CE being used in the field is generally broad, with many different facets of the concept being addressed. Many municipalities (14 out of 21) have constructed their own definition, or expanded an existing one, based on practice and experience working with the concept. This may be a reflection of the diverse understanding in the sustainability field as a whole, as pointed out in chapter 1.5 (Robèrt et al. 2002, 197; Glavič and Lukman 2007). While the scope of the definitions was found to be broad, there was consensus around waste being seen as a resource, which was expected as the concept is rooted in IE (Murray, Skenes, and Haynes 2015, 372).

Findings in this research step also showed that seven of the 21 municipalities involved in this research did not have a working definition of CE. As our introduction indicated, having a clear definition and vision of success is an important component of SSD. This is because it enables a strategic approach through clear understanding and collective agreement on the system being sustained. The prevalence of a lack of definition therefore has the potential to inhibit a municipality’s ability to make strategic choices towards CE. As pointed out by Julia Vol (2017), CE can be understood as both a process and an end state. Municipalities lacking a clear definition of CE may be viewing the concept as a process toward their individual city’s vision, rather than an end state in itself. In such a case, however, a clear definition would still support a common understanding and communication. The remaining 14 municipalities did have a working definition of CE, and are thus in theory able to make strategic choices towards that definition. This ultimately shows that most of the municipalities’ understanding of CE is aligned with the SSD approach of having a clear direction or goal to backcast from.
4.1.2 Definition Format Presents Challenges

The format in which CE is defined is different from the boundary conditions for a sustainable society that are presented in the FSSD. As pointed out in chapter 1.6, the FSSD provides an exclusionary definition of sustainability. It uses basic principles to outline the boundary conditions that must be met in order to preserve the socio-ecologic system in a sustainable manner (Broman and Robèrt 2017, 22). Defining sustainability by taking ‘unsustainability’ as boundary conditions makes it easy to place different activities within or outside these conditions. Activities lying within the boundary conditions, the 8SPs, therefore do not contribute to unsustainability. The CE definitions collected in the field, however, are all descriptive of what ‘could be’. It describes the characteristics of a model, but not its conditions. This open definition format makes it difficult to see when it is applicable, and what is included. For example, ‘Closing the technical cycle’ is more of a characteristic. This format brings up questions like ‘When do I apply this?’ ‘When have I closed the technical cycle?’. It makes it challenging to assess an activity against this definition, and leaves it open to interpretation. When framed in an exclusionary way, this same definition results in a condition, rather than a characteristic. Framing it as a condition could result in something like ‘There must not be a systematic increase of technical waste’. Providing such boundary conditions could clarify the usage of the CE concept.

In addition to the descriptive format of the definitions causing unclarity, another issue of concern arises with the usage of CE principles or pillars. Many CE definitions we found have multi-levels (i.e. pillars), which is also reflected in the synthesized definition that was crafted. This brings up the question of whether a CE action needs to address just one, or all pillars in order to qualify as CE. If a municipality sources their energy from renewable energy, is this a CE action? What if this municipality was using this energy to burn waste? What if that waste could be recycled into a higher value product? This indicates some of the complexity of using multiple pillars, and the misunderstanding of CE that can result.

The descriptive format of definitions, and the usage of CE pillars are two points on which the format of definitions can be critiqued. This presents the CE concept with a challenge in gaining clarity needed for a definition so that it can be approached strategically. The unclear language used could result in rendering CE’s meaning less potent, as has happened with the word ‘sustainability’, resulting in the criticism from researchers presented in chapter 1.5 (Dale, Dushenko and Robinson 2012, 85; Missimer 2015, 2). On the other hand, having such a broad, descriptive definition may stimulate the possibilities of CE through inspiration, particularly in areas like social sustainability or the ecological system.

4.1.3 Circular Economy Takes a Systems Perspective

The definition of CE collected from the field alludes to a systems perspective, which is a foundational aspect of SSD and the FSSD lens, as pointed out in chapters 1.5 and 2.2. The definition synthesized from the field recognizes cycles, both biological and technical, nested
within human society and the ecological system. From addressing collaboration and sharing in the human society, to speaking to new innovative business models within our economic system, the concept of CE addresses many systems, and the connections between them. In addition to this cycle identification and overall systems perspective, CE is also scalable. For example, it can be applied on a consumer product level, an individual company level, a city level, or even a country scale - expanding the system boundaries as appropriate to the application. This makes is a useful tool to complement the FSSD, as this systems perspective is needed to address the sustainability challenge (Seiffert and Loch 2005, 1201).

### 4.2 Circular Economy Implementation in Practice

This subchapter discusses the findings from research step two, using the results, previous literature introduced in chapter 1, and additional insights.

#### 4.2.1 Significant Business Involvement

What stands out in the 87 CE actions collected in research step two is the significant level of business involvement. Businesses are especially included in the action categories ‘Business’, ‘Incubator’, and to a great extent in ‘Collaboration’. Businesses are involved in diverse ways, e.g. through:

- direct support of businesses (e.g. BroodNodig);
- cooperation for innovation (e.g. Lab op Straat in Rotterdam);
- business connection (e.g. Industrial Symbiosis: Connecting Businesses in Gothenburg);
- business incubators (e.g. Urbantech NYC in New York);
- procurement and contracting policies (e.g. Contractor Tendering in Apeldoorn) or
- municipalities initiating businesses to implement CE (e.g. Camp Small in Baltimore or Tegenstroom in Haarlemmermeer).

The examples indicate the different ways cities are trying to stimulate innovation in the business sector to develop solutions for CE. Incubators, procurement and contracting policies (i.e. tendering) have particular capacity for this.

Incubators are one way municipalities can involve and empower local businesses, combining their interest in stimulating the economy, bringing innovation to the city, and developing CE within their city. The prevalence of incubators also indicates that CE is still in an experimental stage, where solutions still need to be proven and developed.

Procurement and creative tendering highlight the bargaining power that municipalities can leverage by integrating CE criteria in their procurement policies. Winans, Kendall and Deng (2017, 830) state that “appropriate policy instruments contribute to the success of […]
innovation and network synergies that help stakeholders meet the [...] challenges of CE-related initiatives”. In fact, policy can fast-track the market to develop CE solutions. For instance, the municipality of Apeldoorn challenged a local cardboard supplier to design a cardboard using their roadside grass, which would have otherwise burned or composted at the expense of the city (Lubberhuizen and Veenhuizen 2017).

4.2.2 Collaboration as a Way to Approach Circular Economy

As the previous subchapter indicates, municipalities have a tendency towards partnerships with businesses. This also relates to the action category ‘Collaboration’ occurring most often. Collaboration of municipalities can also be found throughout all categories where it is not the main intention of the action, but rather a secondary result of it (e.g. Business, Platform and Research). This trend is seen to combat the challenge highlighted by Winans, Kendall and Deng (2017, 830) that “information exchange is cited as a constraint to the success of CE initiatives”.

In addition to collaboration with businesses, collaborations are also carried out in non-business networks and research. The fact that five municipalities are members of the EMF Circular Cities Network stands out from our findings. John Trujillo (2017), Public Works Director in Phoenix, states the importance of partnerships with other cities and with networks like EMF: “[...] we’re still developing [our CE program] and it’s getting better and we’re still learning as we move down that path. And that’s why these partnerships are important”. Municipalities collaborating with each other in this way indicates a commitment to knowledge exchange and an awareness of their guiding role as municipalities. It may also serve as evidence of a need and desire for a better understanding of CE and how it can be applied in cities, which reflects the research gaps found in the literature (Ghisellini, Cialani, and Ulgiati 2016, 27).

There’s an indication that municipalities have a considerable desire to build capacity. This is derived from the finding that municipalities conduct a significant amount of research, have a high level of collaboration with businesses, and actively participate in knowledge exchange through networks. This emphasis on capacity building can either allude to CE being in an early stage or a natural role that municipalities take on within CE implementation. Additionally, this approach emphasizes co-creation between a variety of important stakeholders, increasing engagement and ownership of CE in the city. In addition, accumulating more knowledge on the topic through these various stakeholders can ultimately support the strategic approach a municipality takes.

4.2.3 Under-representation of Actions in Water and Energy Sectors

In opposition to the recurring types of actions cities take, the CE actions found in our research also indicate areas municipalities neglect. What we can observe is an emphasis on material
flows but an under-representation of actions that address water or energy. There were no projects that integrated CE into the water system in the municipalities we spoke with, and surprisingly few CE energy projects. There are many possible reasons for this gap.

First, water and energy projects may rely on larger and more inflexible infrastructure than the material streams - a barrier highlighted by Winans, Kendall and Deng (2017, 830). An example of this is Tegenstroom in the Netherlands: a non-profit renewable energy provider initiated by the city of Haarlemmermeer. While they are able to stimulate local wind and solar power, they also face a significant systemic barrier in being able to offer renewable energy, due to the existing natural gas dependent infrastructure in Dutch homes. For this reason they must continue to provide this non-renewable source as well (Tegenstroom 2017).

It may also be that municipalities see a lack of fully proven or developed technology available, and are therefore hesitant to invest in large infrastructure projects. This would also correlate with the efforts of cities to increase their knowledge and their investment in research around solutions to implement CE.

Another reason for this under-representation could lie in the understanding of CE in the field, where ‘waste as a resource’ is highly common. This understanding may be too narrow. As waste is often understood as tangible materials that can be thrown away, less tangible flows like wastewater and unused energy may be overlooked.

Though there are many probable reasons for this gap in implementation, it remains a notable oversight. Municipalities often have significant long term influence over water and energy systems in the city, and so overcoming these barriers could lead to significant gains in the effective implementation of CE.

4.2.4 Social Aspects of Circular Economy

When we look at the most frequent four codes (‘Human Society’, ‘Intentional Design’, ‘Waste as Resource’, and ‘Business Model’) from our definition analysis, we see that those codes are also most frequently addressed by the actions that were evaluated. It is interesting to note that although the definitions used are very broad and indicate a range of understandings of what CE means, there does seem to be an alignment between the theory of CE being discussed in the field, and the implementation of it in municipalities.

Observing the IE roots of CE (Murray, Skenes, and Haynes 2015, 372) it was unexpected that ‘Human Society’ was also addressed frequently. This showcases a pattern of addressing social sustainability within CE and can be illustrated through actions such as the Baltimore Community Toolbank. The toolbank serves to increase citizen access to tools, negating the necessity to own your own (Cook 2017). It is a service for citizens, as well as a strategy to limit materials entering the consumer waste stream. This frequency of social considerations underlines the relevance of the CE concept for application in municipalities, as it highlights
the potential for benefits to citizens. These examples also showcase the multi-dimensional quality of CE actions, illustrating how different parts of the definition can be addressed to strengthen the impact of a project.

4.3 Strategic Implementation Towards Sustainable Development

This subchapter discusses the findings from research step three, using the results, previous literature introduced in chapter 1, and additional insights.

4.3.1 Alignment with the Sustainability Principles

We can see in the results of the third research step that the majority of the SP misalignments occur due to dependencies on nonrenewable energy. These dependencies are represented as misalignments to SP1. Four actions of 87 are misaligned with SP1, and another eight actions were listed as ‘precautionary yes’. Often times this was due to businesses and their lack of access to renewable fuel sources for equipment. In the case of electricity this can often be solved by switching to a renewable energy provider, however, other times it is more complex with regards to the existing infrastructure, as discussed earlier. This does not indicate the unworthiness of some of these projects, but perhaps serves to highlight the importance of system-level projects. Actions that build local renewable energy capacity, for example, can then work in conjunction with more singular actions that rely on that system.

Overall however, within the scope and limitations of our research, the vast majority of CE actions implemented by municipalities are taking place within the boundary conditions of a sustainable society described by the FSSD. This suggests that CE is indeed a valid tool to be used in the transition to a sustainable society.

4.3.2 Financial Revenue or Savings Not Common

Although the SP analysis indicates that the CE actions municipalities have implemented are within the boundary conditions of a sustainable society, that assessment alone is not enough to conclude their strategic contribution towards it.

Upon assessing municipalities’ implemented CE actions on their strategic approach, we found that the CE actions that do not contribute to potential financial savings or revenues were more frequent than those that did. This question was included, because it captures an action’s ability to generate savings or revenue that can then provide the resources to enable further actions. For instance, the municipality of Haarlemmermeer initiated Meermaker, a fund that co-finances innovative sustainability projects in the region (Tuinstra and Ruis 2017). This initiative provides an opportunity for a continuous realisation of new businesses supporting
the sustainable development of Haarlemmermeer, as the fund is sustained on the collected interest.

The actions that did not contribute to potential financial savings or revenues can largely be attributed to the fact that a lot of these actions are geared towards collaboration, policy, platforms or communication. When value comes from knowledge exchange and building capacity to integrate CE, there is not always a particular need for a financial incentive. While this might not align with the SG question on financial savings or revenue, these are actions that are crucial for expanding the city’s knowledge and innovation. It could also be argued that due to the role of the municipality as a public agency in support of citizen well-being, they are in a position in whereby the continuation of an action is not dependent on financial return. Their role can be seen to empower and create possibilities for citizens and businesses to catalyze CE through collaboration, platforms and policies.

We found that cities that combine actions that generate revenues/savings and actions that do not (e.g. collaboration, policy, platforms or communication) can support each other and provide a strong integration for CE in the city on various levels. For instance, the ‘Circular Peterborough Commitment’ brings together local businesses to engage them in a circular city vision. While this initiative does not generate financial revenue, it ties into the membership success of their ‘Share Peterborough Platform’ in which these businesses can exchange materials and other resources, and will later be commercialized to financially sustain itself (Thomas 2017).

In summary, the financial return of an action can indeed contribute to its strategic approach. In the context of a municipality, however, the mandate of the municipality should also be considered. In this context, perhaps value generation should be regarded with a broader definition to include more social aspects regarding the well-being of the citizenry.

4.3.3 A Strategic Choice Towards a Sustainable Society

Our third research step concluded that the majority of CE actions provide a stepping stone for further actions to contribute to the development towards a sustainable society. Many CE actions that were implemented were geared towards setting a first step towards CE. This was often in the form of building partnerships, creating new business/markets, and increasing their own awareness. This reflects how municipalities are using capacity-building as a strategy to support CE in their cities.

When we looked at the CE actions and their impact on the citizens, the majority of them contributed to a positive impact. Although there was limited data available for this analysis, an example of how positive impact can be shown is through the Backsippan C2C Kindergarten in Ronneby. The facility is built to C2C standards, replacing a run-down building with a high environmental standard alternative. Not only did this project provide a chemical free, healthy environment for children to learn, it also provided an opportunity to
educate the citizens about CE principles (Svensson 2017). As stated in chapter 3.3.2, the actions where no positive citizen impact was seen still showed benefits for the municipality or business. Hence, there was always an important stakeholder group benefitting from an implemented CE action.

These strategic alignments, combined with the CE actions largely being assessed as lying within the boundaries of the 8SPs, shows that CE is an appropriate tool for municipalities wishing to contribute to SSD. Although the current CE actions in cities can contribute to movement in the right direction toward a sustainable society, it is outside of the scope of our research as to whether or not CE is a sufficient strategy to reach that goal.

Additionally, as stated in chapter 1.4, CE is not only seen as a tool by some, but also as a ‘new school of thought’ (Murray, Skene and Haynes 2015, 377) that requires ‘radical transformation’ of the current paradigm (Gregson et al. 2015, 235). Although outside the scope of this research, when looking at CE from this perspective, questions are raised regarding what the end state of this new system might look like. There is currently a lack of research into what a fully ‘circular’ city would entail. This brings up a question of the future of CE in cities, and whether municipalities will continue to use CE as a tool in their own overarching strategy, or choose to fully adopt it as a transformative, end state vision. The requirement of a clear goal in order to strategically address the sustainability challenge (Broman and Robèrt 2017, 19) is challenged, however, by the ambiguity of this possible end state of CE.

### 4.4 Recommendations

As mentioned in our introduction chapter, cities are proven to be important leverage points when addressing the sustainability challenge. Our research concludes that CE can be used as a tool to contribute to SSD. This subchapter provides our recommendations, based on the results and discussion of this research, with an underlying motivation to inspire and inform municipalities. For references to CE actions in cities, see Appendix D.

**Recognizing and Leveraging Influence**

Municipalities are in a unique position to design, plan, manage, and monitor the city. In order to leverage that position however, they must first recognize their areas of highest influence, which are highly context dependent (e.g. Circle Scan in Amsterdam, Material Streams Identification in San Francisco). For instance, some municipal agencies may own and operate their own public utilities, while others may be in partnership with private companies, or may contract out to the private sector. Some possible areas of influence were touched upon in the discussion, and may include: public utilities (e.g. water, energy, waste), policy, procurement, built environment, communication, fund distribution, and knowledge of industry/business activities in the city.
Based on the complexity of the system CE operates in, we recommend that municipalities invest in some initial research to understand which areas they may have the greatest influence to stimulate CE in their city. This provides direction and can ensure that resources are used effectively for greatest impact. For example, integrating CE criteria in procurement policies may be an effective way of leveraging bargaining power in order to stimulate CE in the market (e.g. ‘De Parken’ tendering process in Apeldoorn, Cardboard from roadside grass in Apeldoorn). However, long term contracts may prohibit such flexibility. In that case, funding an innovation incubator could be a more effective means to the same end (e.g. Meermaker in Haarlemmermeer, Urban Tech NYC in New York). Another example that is effective, based on our research, is when municipalities identify and address large, unwanted, material streams in their city. In the case of organic material, CE actions showed effectiveness when municipalities included local businesses and challenge them to turn this waste material into something valuable for the region (e.g. [Re]verse Pitch Competition in Austin, Green and Digital Demonstration Program in Vancouver).

Adapting to Culture
Cities vary in their culture, and therefore its citizens and their willingness to adopt certain policies and interventions also vary. This also means that the message of CE might need to be adapted according to that culture. Municipalities may want to ask what is important to their citizenry. For instance, are they open to recycling policies? Do they need to be financially incentivized? Similar questions should be asked for the local businesses and industry. Is there a culture of experimentation and innovation? Is employment a priority? Depending on the context of the city, CE can be communicated and applied accordingly. One advantage of CE, as reflected in its broad definition, is that it can be looked at from different perspectives, especially as it combines both environmental and economic components.

Need for System-Level Solutions
The sustainability challenge calls for a systemic approach that addresses upstream solutions. For example, not just looking at the solutions to divert frequent products that end up at the landfill, but also solving the root causes of those materials existing in the first place. An upstream solution could be to collaborate with manufacturers of those products and redesigning their products to be optimally recycled, repaired, or reused within the local or regional context (e.g. Producer Partnership in Oslo). While municipalities may first be focusing on CE actions that reap low hanging fruit, another important factor in CE as a strategy for a municipality is understanding what system-level barriers are present. For example, specific policies or existing infrastructure may just be in the way of the potential of CE in a city.

Need for Internal Education
The establishment of departments or working groups for CE is common, however, the internal education of departments and the interdepartmental relationships must be given significant attention as well. As seen in the broad scope of the definition, CE is not limited to one department, but can be applied on many levels. While you may have one department that
focuses on supporting CE implementation as a whole, the other departments must also be aware of their role and how CE as a tool can benefit their operations (e.g. CTO office in Amsterdam).

4.5 Strengths and Limitations

There are several limitations, but also strengths with regard to this research. With an awareness of this, we were able to use different strategies in order to maintain the quality of our research process.

On a general level, we acknowledge the limitation that all team members contributing to this thesis come from a background in sustainability science. We thus may bring preconceived notions about sustainability and the potential for the impact of CE on sustainable cities. Also, the limited time available for this research has influenced the depth of the analysis.

One of the limitations we came across refers to the cities included in our research. The fact that we concentrated on cities that have publicly communicated their CE implementation in some way may have eliminated cities from our research who have not communicated their implementation. This creates a potential oversight based on municipalities’ quality of communication and searchability. As our scope is global, and the way that cities are implementing CE is often highly dependent on local context, there is a limitation in the transferability of actions discussed in this research. We did, however, try to reduce this limitation by identifying regions that may be under-represented and conducting specific research in those under-represented regions to improve the geographic distribution of our cities. Despite this attempt, there are still countries or regions where we were unable to gain access to practitioners (e.g. China).

Secondly, we recognize that the position and department of the specific person we interviewed at each municipality may have a significant influence on the outcomes of the interviews. In this sense, the issues associated with self-reported data, such as selective memory, or false attribution of events may have affected our results. Many practitioners are enthusiastic about their projects, and may have a tendency to communicate them with exaggerated positivity. By having this awareness, we emphasized clarifying the roles of the interviewees and their departments. This helped us to put the results of the interviews into the correct context for each city. We also verified much of our interview data with online publications.

Another point that might be touched on is the method of open coding in step one and two of our research. As the codes were not pre-generated, but were rather based on the data to allow patterns to emerge throughout the process, the replicability of that particular method may be limited. Re-iteration steps in the process of code generation were taken, however, to ensure the most accurate codes. To do that, we leveraged our team’s diverse perspective, coding and
recoding with different members of the team checking through each other’s work and justifications.

Lastly, we recognize that due to our time limitation the action assessment against their contribution to SSD is not an in-depth analysis. We therefore acknowledge that the analysis may have missed some nuance, and that it underlies subjective ratings to a certain extent. We did, however, include several steps of re-iteration to improve the credibility of the assessment, and acknowledged the instances where insufficient data was available to make an assessment. Additionally, the fact that we work as a group of three helped to strengthen the evaluation.

Despite the above stated limitations, the research conducted also shows various strengths in its approach. In general, the research provides an overview over the field instead of focusing on a singular case study. This creates the possibility to understand trends and themes that occur in the field of CE in the context of cities on an aggregate scale. This strength shows its value particularly in the first step of the research. There, a mixture of definitions for CE from the field were combined with definitions from organizations and institutions. The broad overview enabled us to analyze and synthesize a strong definition that reflects the current understanding in the field.

Additionally, we concentrated on actions from cities that are already implemented and rejected expected actions that were not yet operational. This helped give an overview of the actual field and avoided results being falsified by intentions of cities that may not continue beyond the planning phase.

4.6 Areas of Further Research

Based on questions that arose throughout our research, we recommend several areas of further study, highlighted in the following subchapter.

For instance, it would be interesting to investigate the connection between the role that a municipality plays in the integration of CE, and their stage on their CE journey. As many municipalities told us that CE was a new concept for them, there may be a connection between that stage of infancy, and the heavy emphasis on collaborative projects. Perhaps there are different phases that require different roles, clarity on which could then help municipalities better identify strategic actions to take. We also saw evidence of many different approaches to CE integration in municipalities. Some had dedicated CE departments or working groups, some had managers within other departments like sustainability or economic development, while others had a singular champion of the cause that served to push the concept throughout the organization. Further research into comparing the effectiveness of these various approaches would advance the strategic application of CE.
We also observed a difference in the actions being taken, particularly in policy, with regard to citizen behavior between different regions. An area of further research may be to build on this idea and look at the influence that different cultural norms play on a municipality’s role in CE implementation. This can be complemented by researching what communication strategy would be most effective in the different contexts.

As discussed earlier, investigation into an exclusionary definition of CE may also move the field forward by providing clarity. The definition of the field that was synthesized in this research may be ‘reversed’ to create boundary conditions. Based on this finding, boundaries of what doesn’t constitute CE can be researched and may create a more communicable understanding of the concept.

A strength of CE is that it can be applied on many different system levels. We saw evidence of various levels of application, even within the city system. These ranged from innovation hubs testing out CE solutions, down to citizen campaigns to promote recycling efforts. Better understanding of how these different scales of projects can be complemented and leveraged for impact amplification could drive the application of the concept forward and provide guidance to municipalities about how to position themselves within these different scales of systems.

Finally, an area of further research based on our findings is the investigation of the concept of a ‘circular city’. Further research could clarify what this looks like, its feasibility, and also its desirability in the context of a sustainable society. This could provide municipalities with additional clarity on whether to pursue CE as an overarching goal for their city.
5 Conclusion

CE is increasingly being used a tool to address the sustainability challenge. The purpose of this research was to understand the ways in which CE is currently being implemented by municipalities, and how this may contribute to the development of a sustainable society. With this information, we aimed to bring clarity to municipalities on whether or not CE can be used as a strategic tool to address sustainable development, and if so, how they might use their unique position to integrate this concept in their city.

The definition analysis found that the definitions from the field are broad, and ultimately present challenges for working strategically towards a sustainable society due to their descriptive format. We did, however, also find that CE as it is currently understood, provides a systems perspective. This is vital to success when working in complexity, so in this way, CE shows potential to contribute to the development of a sustainable society.

The collection of 87 actions implemented by municipalities in 21 cities showed that materials projects were also very common, with an unexpected under-representation of water and energy projects. This is a notable oversight for effective CE integration. In addition, research found that business involvement and collaboration is very prevalent, with the most actions reflected in these categories. This illustrates the role of municipalities to build capacity for CE in their cities.

Through our assessment of implemented actions, we found that the vast majority fell within the boundary conditions for a sustainable society provided by the FSSD. Most actions also aligned with a general strategic approach, although the financial aspect is weaker in some actions than others. This indicates that, overall, CE is an appropriate tool for municipalities wishing to contribute to SSD.

For effective implementation, we recommend municipalities investigate where their areas of influence are. We also see that internal education is vital to embed the concept in the organization and allow municipalities to take advantage of the interconnectedness and synergies of different departments. This also assists in identifying systemic barriers which may inhibit the ability of municipalities to enable and build capacity towards CE.

This research sought to answer the question: How does the current implementation of CE contribute to the strategic development of a sustainable society?

Overall, we found that the current implementation of CE by municipalities contributes to the strategic development of a sustainable society. It does so by enabling capacity building within the city and using CE as a tool to marry sustainability goals and economic ones. If CE implementation continues in this way, it will continue to contribute to SSD. This way of applying CE as a tool, however, may limit the opportunity presented by the concept. The systems perspective of CE holds potential for radical systems change, while its current
understanding and use, as well as its placement embedded within the current system, does not foster that potential. Based on the findings of this research, at this stage, CE can be used by municipalities in complement with other tools available to move towards the larger goal of a sustainable society.
References


Underwood, Chris and Patrick Chauo. Interview (written) by authors. March 21, 2017.


Appendices

Appendix A: Synthesized Definition of Circular Economy Sources

The following table presents a comprehensive list of the sources used in the CE definition synthesis carried out in Step 1 of the research:

<table>
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<th>Source</th>
<th>Organization Type</th>
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<td>CE Consultancy</td>
<td>Oslo</td>
<td>Cities &amp; Regions</td>
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<td>Educational Institutions</td>
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## Appendix B: Cities and Interviews Included in the Research

The following table presents all cities, the main data collection source and all persons that were interviewed for this research.

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<td>Andreas Sawatzki</td>
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Appendix C: Number of Actions per City

The following table shows the number of actions per city gathered in the data collection for the second research question.

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**Total: 87**
## Appendix D: Summary of Actions Collected

The following table presents an overview of the actions that were included in this research, by category.

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Appendix E: Action-Subcode Frequencies

The following tables shows the subcodes and their frequencies that occurred in the data analysis of the actions collected in the second step of the research.

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