Master's Thesis – master Innovation Sciences

Utrecht University

Institutional Strategies in Technological Innovation Systems

The Case of Decentralized Sanitation Solutions in eThekwini and the City of Cape Town

Jordi Maijenburg
j.maijenburg@students.uu.nl

Supervisor	Dr. Xiao-Shan Yap
Second Reader:	Dr. Ir. Frans Sengers
Date:	30 October 2020

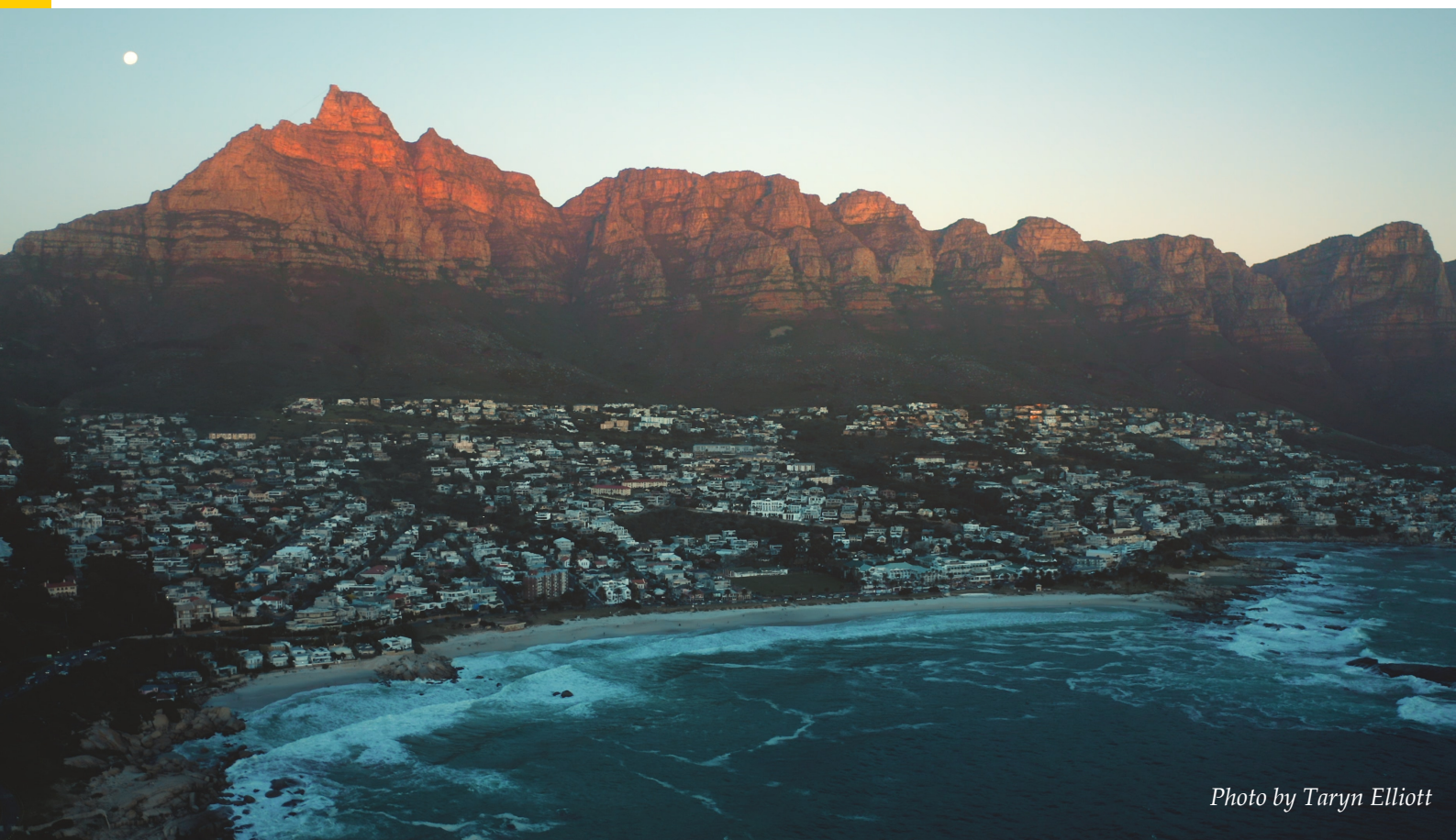

Photo by Taryn Elliott

Summary

Only half of the South African households in informal settlements have access to sanitation services. Decentralized sanitation solutions such as urine diversion toilets or communal ablution blocks are considered the only feasible alternatives to increase sanitation access in South Africa due to economic and topological conditions. However, these solutions are met by many protests as it is intertwined with inequality for a large number of citizens. Therefore, the initial social acceptance of these solutions is low.

South Africa has a background of political challenges but still has much capacity to engage in innovation, as it is the largest economy in sub-Saharan Africa and has a culture of innovation. In this context, eThekwini Municipality successfully implemented some decentralized solutions in the past ten years, while decentralized solutions remained heavily contested in the City of Cape Town. Since these municipalities are located in the same country with similar cultural and political contexts and similar funding, the question remains how one municipality could better overcome low social acceptance than the other.

The technological innovation system (TIS) approach was used to understand and explain the innovation processes of decentralized sanitation solutions in both municipalities. Since social acceptance has rather critical influences on the overall innovation performance in both municipalities, the system function legitimation was further deepened with the concept of institutional work strategies. Based on 270 news articles and 8 policy reports, an event analysis was performed to trace the most important actors, networks, and institutions regarding decentralized sanitation and those actors' institutional work strategies. Furthermore, the influence of these strategies on the systems' performance was analyzed.

eThekwini managed to create a coherently aligned TIS for decentralized sanitation through longstanding partnerships with resourceful partners, trust with citizens created through institutional work, and the successful institutionalizing of accumulated knowledge thanks to overall stability. The City of Cape Town had tremendous difficulties implementing decentralized sanitation due to a lack of trust and partnerships resulting from political misalignment, intense protests, and increased bureaucracy resulting from past failures.

This thesis illustrates that the combination of the TIS and institutional work approach allows scholars and policymakers to better understand the actors' individual actions and the influence of these actions on TIS performance.

Table of Contents

1. Introduction

One of the 17 Sustainable Development Goals (SDGs), aimed to end poverty and other deprivations, is clean water and sanitation for all (United Nations, 2020b). Currently, a quarter of the world's population does not have access to basic sanitation services (United Nations, 2020a). South Africa is one of the countries not able to provide sanitation services to all its inhabitants. Although 80% of the households have access to sanitation services, this decreases to 50% of the households based in informal settlements, often located in rural areas (DWS, 2019). Sewer connections in these settlements are not considered feasible due to technical, financial, environmental, and political constraints (Sutherland, Hordijk, Lewis, Meyer, & Buthelezi, 2014). Therefore, decentralized sanitation solutions are installed, such as urine diversion toilets, communal ablution blocks, or portable flush toilets (Pan, 2016). These solutions are also seen as part of the solution to drought, shortage of nutrients, and lack of landfill space by treating the waste onsite and recycling water and nutrients at the source (Robins, 2014).

Sustainable development, such as decentralized sanitation, is not just a technological issue but is heavily intertwined with political values and choices (Scoones & Stirling, 2020). Decentralized sanitation solutions are met by much resistance in South Africa, as for many citizens, it is intertwined with inequality (Galvin, 2016; Redfield & Robins, 2016; Robins, 2014). A regular flush toilet is culturally seen as a sign of modern citizenship, while decentralized sanitation, forced upon the poor informal settlements, are associated with the *apartheid* past and racial segregation (Bond, 2020; Redfield & Robins, 2016; Sutherland, Scott, & Hordijk, 2015). People reject these technologies as they consider them second-class solutions for second-class citizens (Robins, 2014). All in all, Redfield and Robins (2016) conclude that creating social acceptance for these solutions is the key to the success of implementing decentralized sanitation solutions.

South Africa has a unique position on the African content in terms of economic development (Vadra, 2017). In 2011, it became a member of BRICS, a group of five fast-growing developing economies in transition to a knowledge economy. The country is known for its culture of innovation, easy access to financing, and effective regulatory frameworks. Within this context, two exemplary cases of decentralized sanitation can be found in the eThekwini Municipality and the City of Cape Town, two of the three largest municipalities in South Africa (Stats SA, 2012). Although both municipalities had the same starting conditions with similar funding and cultural context, the outcomes were very distinctive. Whereas eThekwini is internationally lauded for its approach to decentralized sanitation, the City of Cape Town is internationally known for the high number of protests on municipal service deliveries related to decentralized sanitation solutions (Pan, 2016). In eThekwini, state and non-state actors interact in so-called state-citizen relationships, which led to an increase in citizen trust and social acceptance (Martel & Sutherland, 2019; Sutherland et al., 2014).

Simultaneously, the City of Cape Town tried various decentralized solutions but could not build a coherent system surrounding these solutions.

Within the same country, under similar contexts, decentralized sanitation solutions were successfully implemented in one region while continuously contested in another region. It is not yet clear, under what local contexts and conditions, activities contribute to or inhibit the legitimation of decentralized sanitation solutions. Therefore, this thesis aims to analyze the differences between the two municipalities in terms of innovation processes and legitimation activities regarding decentralized sanitation solutions to better understand the success factors and barriers driving this transition.

The technological innovation system (TIS), as coined by Carlsson and Stankiewicz (1991), is the most appropriate framework for this analysis as it was designed to understand and explain the processes of innovation within a specific technology or technology group, such as decentralized sanitation solutions. The dynamics of actors, networks, and institutions are analyzed to explain the system's performance (Edquist, 1997). Hekkert, Suurs, Negro, Kuhlmann, and Smits (2007) proposed seven functions that contribute to the performance of the TIS, such as *knowledge development and diffusion, guidance of the search*, and *legitimation*. Through the event analysis method, relevant events related to the technology are mapped onto the system's functions, and the interaction between the system elements and the performance of the system functions can be analyzed (Suurs & Hekkert, 2009).

Although the TIS approach has been considerably successful to analyze and describe transitions, it has also been criticized for downplaying the complexity of legitimation processes (Markard, Hekkert, & Jacobsson, 2015; Scoones et al., 2020). New technologies are often not aligned with institutional structures leading to a contradiction between the technology and already established cultural norms and worldviews (Binz, Harris-Lovett, Kiparsky, Sedlak, & Truffer, 2016). Therefore, actors need to legitimize new technologies through various deliberate actions. This is especially true for the two cases of this study because these technologies have very low social acceptance to begin with. To better understand this process, the framework by Binz et al. (2016) is adopted, which unfolds the *legitimation* function of the TIS by introducing several sub-processes such as *political work, the creation and mobilization of coalitions*, and various other forms of so-called institutional work (Binz et al., 2016; Fuenfschilling & Truffer, 2016). These sub-processes are included in the event analysis to focus on the system function *legitimation* in the innovation processes.

Both municipalities have their own TIS regarding decentralized sanitation with different structures. Although the municipalities receive national and provincial funding to meet their obligation to provide all citizens with basic services such as sanitation, each municipality can follow its own trajectory with its own policies and technologies to meet this obligation (Reddy, 2016). The period from 2010 to 2020 is analyzed. Around 2010, some new actors and policies entered the TISs in both municipalities that directed the municipalities'

sanitation efforts towards more decentralized solutions. Both practicalities are further elaborated on in the methodology section.

The following research question guides this thesis:
How did actors in the decentralized sanitation TISs in eThekwini and the City of Cape Town try to legitimize decentralized sanitation services, and how have these actions impacted the systems' performances from 2010 to 2020?

This research question consists of four sub-questions that collectively answer the overarching research question.

1. Which are the most important actors, networks, and institutions forming the TISs concerning the decentralized sanitation sectors in eThekwini and the City of Cape Town?
2. How well are the system functions fulfilled for these decentralized sanitation TISs for both municipalities?
3. Which types of institutional work can be distinguished, and how did they affect the systems' performances?
4. What inducement and blocking mechanisms support or hinder the performance of the decentralized sanitation TISs?

This research combines and applies theories, thereby posing propositions rather than testing hypotheses (Bryman, 2012). By bringing together and analyzing an extensive collection of events in these two municipalities, inducement and blocking mechanisms are identified in both municipalities, which could provide useful lessons for other municipalities in developing countries with constraint access to basic sanitation services. Theoretically, this study explores the role of institutional work in TIS development more explicitly by combining the meso-level perspective of the TIS with the micro-level analysis of institutional work to better understand the influence of individual actors and their activities on overall TIS development. This aligns with the recommendation of Binz et al. (2016) for further research, to put a focus on which actors drive what processes regarding legitimation, and how this influences individual TIS functions.

In the next section, a theoretical review of the TIS and the role of institutional work is provided. After that, the methodology section describes the practical steps for determining TIS structure and performance. The results section gives an overview of the findings of the event analysis and expert interviews. After that, the conclusions section answers the research questions, after which implications and limitations are discussed in the final discussion section.

2. Theory

This section provides a literature review on the sanitation sector, innovation system dynamics, and institutional work. In the first subsection, the sanitation sector is conceptualized. The second subsection presents a brief historical overview of the innovation systems approach. After that, the technological innovation system (TIS) is described in the third subsection. Lastly, institutional work is elaborated on in the fourth subsection, followed by a summarizing paragraph on the combination of these theories.

2.1. Decentralized Sanitation Sector

Sanitation can be considered a basic service sector (van Welie, Cherunya, Truffer, & Murphy, 2018). Basic service sectors are usually conceptualized as a regime with consistent levels of quality throughout the service, governed by a dominant authority. This thesis specifically focuses on decentralized sanitation solutions. In South Africa, Pan (2016) observed four main groups of decentralized sanitation solutions, divided into dry and wet systems with either on-site or off-site disposal. Within these groups, several combinations of technologies exist. Each of these combinations describes a decentralized service consisting of the technologies and practices within the sanitation chain including user interface, collection and storage, conveyance, treatment and use or safe disposal (Tilley, Ulrich, Lüthi, Reymond, & Zurbrügg, 2014; van Welie, Truffer, & Yap, 2019). Through the innovation systems approach, the implementation of new technologies into sanitation chains is analyzed. This approach is discussed in the next subsection.

2.2. Innovation Systems Approach

The innovation systems approach emerged during the late 1980s to study innovation processes. New insights led to the assumption that not just the quantity of specific inputs lead to a particular output, but that the configuration of the elements of the input and the interconnectedness also play a role in the rate and direction of the output (Edquist, 1997). Several variations on the innovation system were introduced with different geographical, sectoral, and technological delineations throughout the years. These different innovation systems share the underlying theory that the configuration of actors, networks, and institutions, and their interactions determine the system's performance. The differences between the systems are primarily the system boundaries and the available methodological approaches. Carlsson and Stankiewicz (1991) suggested the TIS as a way to explain how actors interact under a particular institutional infrastructure to generate, diffuse, and utilize certain technologies. The delineation of a TIS has many dimensions, such as spatial focus, the breadth of the technological field, and vertical scope (Markard et al., 2015). The decentralized sanitation sectors in both municipalities consist of a range of technology variants (breadth of the technological field), including several parts

of a value chain (vertical scope) and have a local focus (spatial focus). The TIS delineation fits well with the conceptual boundaries of the case and can be combined with advanced methodological approaches such as the event analysis (Suurs & Hekkert, 2009). The event analysis is further discussed in the methodology section.

2.3. Technological Innovation System Dynamics

The goal of the TIS is to develop, apply, and diffuse new technological knowledge (Bergek, Hekkert, & Jacobsson, 2008; Hekkert et al., 2007). Actors, institutions, and networks form the system structure (Bergek et al., 2008). Their configuration leads to activities that may or may not contribute to the goal of the TIS. These activities are grouped into the functions of innovation systems. The structure and functions of the TIS have proven to be a solid basis for a systematic analysis of the development of the TIS (Markard et al., 2015). Furthermore, Hekkert et al. (2007) argued that the lower number of actors, networks, and institutions of this delineation compared to national or sectoral innovation systems, allows for an analysis of not only the current state of the system but also of the development of the system.

Table 1 provides an overview of the structural dimensions, their description, and subcategories.

Table 1. Structural dimensions of the TIS (Bergek et al., 2008; Markard et al., 2015; Wieczorek & Hekkert, 2012)

Structural dimensions	Descriptions	Subcategories
Actors	All actors within the whole value system that divide labor through specialization	Civil society Companies Knowledge institutes Government NGOs Other parties
Networks	Relationships between the actors	Learning networks Political networks
Institutions	The formal and informal rules that regulate how actors interact and what society values, and thereby influence decisions within the TIS	**Formal:** rules, laws, regulations, instructions **Informal:** Customs, common habits, routines, established practices, traditions, ways of conduct, norms, expectations

Hekkert et al. (2007) and Bergek et al. (2008) categorized the activities leading to a high-performing TIS into seven functions. These functions have been proposed and validated by many case studies.
Table 2 provides a list of the functions, descriptions, and indicators for these functions.

Table 2. Functions of the TIS (Aldrich & Fiol, 1994; Bergek et al., 2008; Hekkert et al., 2007; Suurs & Hekkert, 2009)

Functions	Descriptions	Indicators
Entrepreneurial activities	The entrepreneur experiments with new knowledge, networks, and markets to find new business opportunities	Project entries/exits, portfolio expansion
Knowledge development	Learning-by-searching and learning-by-doing	Learning-by-doing and learning-by-exploring activities
Knowledge diffusion through networks	Exchange of information	Networks, coalitions, meetings
Guidance of the search	Incentives and pressures for actors to perceive specific opportunities and act on it, influence on the process of selection	Standard setting, expectations, outcomes of studies, promises
Market formation	New technologies may offer only small advantages at first and need a protected environment to be able to develop	Niche markets, tax exemptions
Resources mobilization	Ability of actors to mobilize human and financial capital, and complementary assets	Investments and subsidies
Legitimation	The process of creating cognitive and socio-political legitimacy	Acceptance of new technology

These functions are non-linear, meaning they interact with each other (Hekkert et al., 2007). Fulfillment of one function could lead to other functions' fulfillment and thereby cause a virtuous cycle of positive change. These cycles are called motors of change. Contrarily, problems with the presence or quality of the structural elements, so-called systemic problems, can negatively influence several functions (Wieczorek & Hekkert, 2012). By mapping the events that occur within a decentralized sanitation TIS, one can explain the performance of the decentralized sanitation sector and distill mechanisms that support or hinder TIS development.

As explained in the introduction, there will be an explicit focus on the system function *legitimation* as the acceptance of decentralized sanitation solutions is considered key to positive TIS development. The next subsection elaborates on institutional work literature to unfold this system function.

2.4. Institutional Work

According to Scoones et al. (2020), transformations with humanitarian, ecological, and technological visions require changes at various organizational levels and scales. These transformations are often accompanied by new technologies that conflict with established norms and regulations, leading to doubts about the usefulness of these new technologies (Freeman, Carroll, &

Hannan, 1983). The alignment of new technologies with established institutions is called *legitimation*, the TIS's seventh function (Hekkert et al., 2007).

Legitimation is a crucial process for actors endorsing novel technologies to attract resources for growth and continuous development (Markard, Wirth, & Truffer, 2016). The goal of legitimation is to gain cognitive and sociopolitical legitimacy (Aldrich & Fiol, 1994). Cognitive legitimacy refers to how familiar a technology is and can be measured by the level of public knowledge about the technology. Sociopolitical legitimation refers to the acceptance of a specific technology and is the result of certain actions by actors to have other actor types perceive the technology as appropriate and right.

Although TIS has proven to be successful in describing the development of technological innovations, it has also been criticized for lack of depth in understanding how legitimacy may be created (Markard et al., 2015, 2016). The performance of this system function is measured through the rise and growth of interest groups and their lobby actions (Hekkert et al., 2007). However, this does not provide insights on how the various actor types try to induce or block the legitimation process and why they do (not) succeed. Since legitimation is considered an essential process in the transition of sectors, it needs to be further deepened to understand better the success or failure of specific transitions (Fuenfschilling & Truffer, 2016).

The concept of institutional work tries to unfold this process by looking into what actions are performed by whom to create, maintain, or align institutions (Fuenfschilling & Truffer, 2016). These actions are categorized into various types of institutional work. Binz et al. (2016) further developed this framework and linked it to the stages of TIS formation. They suggest that in each step of TIS formation, other institutional work types occur and that these actions interact with TIS functions.

From this framework, the types of institutional work are included in this research. The actions related to the system function *legitimation* can be categorized into one of these types. A list of these types with descriptions is included in Table 3.

Table 3. Types of institutional work (adapted from Binz et al. (2016) & Fuenfschilling & Truffer (2016))

Type of institutional work	**Description**	**Goal**	**Examples**
Constructing normative networks	The construction of inter-organizational connections in order to normatively sanction practices and monitor and evaluate developments	Creating new institutions	Expert groups, committees, associations or advocacy groups that evaluate the developments
Theorizing	The development of abstract categories and chains of cause and effect	Creating new institutions	Scientific models, developing concepts, creation of shared language
Changing normative associations	The connection process of new sets of practices with moral and cultural foundations	Creating new institutions	Introducing business-like managerial practice into utilities
Valorizing	The provision of positive examples to illustrate the normative foundation	Aligning institutions	Awards, influencers
Demonizing	The provision of negative examples to illustrate normative foundation	Aligning institutions	Blaming of other actors for issues around the development
Educating	The process of educating actors with the skills and knowledge to support new practices	Aligning institutions	Campaigns, presentations, guided tours
Mimicry	The association of new practices with existing sets of practices, technologies and rules	Aligning institutions	Introduce innovation in daily life experiences
Imagery	The use of images to associate an issue with danger of pleasing experiences	Aligning institutions	Pictures of vandalized, broken and dirty toilets
Advocacy	The mobilization of political and regulatory support	Aligning institutions, maintaining institutions	Using communication, lobbying and meetings to convince politicians, public or investors
Political work	The use of political power in order to shape or maintain institutions	Aligning institutions, maintaining institutions	Diversion of issues from their meaning to achieve political goals
Mythologizing	The creation or preserving of certain myths to preserve the normative foundation of institutions	Maintaining institutions	Stories about great achievements and projects

2.5. Combining TIS and Institutional Work Analysis for the Case of Decentralized Sanitation in South Africa

This thesis aims to analyze how actors tried to legitimize the decentralized sanitation solutions and what the effect of the legitimation process was on the TIS performance. TIS and legitimation are interconnected concepts. *Legitimation* is one of the system functions in the TIS and influences the performance of other system functions. However, it remains unclear how actors try to legitimize decentralized solutions and under which conditions they tend to succeed or fail. By unfolding this system function, specifically which actors performed what actions, the driving and opposing actors and their strategies for (de)legitimation can be distinguished. This will help us better understand how eThekwini could legitimize decentralized sanitation while the City of Cape Town could not overcome low social acceptance.

The combination of these two approaches could lead to insights on different levels of analysis. Binz et al. (2016) looked into the legitimation activities related to system maturation. They took an actor-based perspective to trace the agency of driving actors in various formative stage of the TIS. This thesis also adopts an actor-based perspective by tracing the actions performed by actors and treating them as events in the event analysis method. By integrating the institutional work into the event analysis, it can be identified how legitimation activities influence the various TIS functions.

3. Methodology

This section elaborates on the methodological approach for this thesis. In the first subsection, the methodological approach is substantiated, including the event analysis method. After that, the selection of the two cases is justified. The third subsection elaborates on the data collection through the relevant search engines and expert interviews, after which the fourth subsection expands on the analysis to arrive at answers to the research questions. Finally, the last subsection substantiates the research quality of this thesis.

3.1. Methodological Approach

This thesis follows an abductive qualitative data analysis approach (Peirce, 1934; Timmermans & Tavory, 2012). Abduction was coined by Peirce (1934) to describe a research approach that is in between deductive and inductive. It differs from an inductive approach as it does not start from the gathered data but instead starts from a broad theoretical foundation to gather the data (Timmermans & Tavory, 2012). If research evidence arises that cannot be explained by current literature, modified theories are presented based on the data analysis (van de Ven, 2007). Through a non-linear process, the most plausible explanations are checked against the data throughout the research.

The data analysis was conducted through an event analysis, referred to as a mixed-methods approach (Suurs & Hekkert, 2009). It was designed on the notion that the performance of each function of the TIS can be determined based on the set of activities that collectively lead to the performance of each system function. To analyze these activities, one should collect all relevant events and group them to the system functions. The temporal dispersion of the number of events within a system function provides the major pivot points in the development of the TIS (quantitative), and the content of the events represent what happened and how (qualitative). This is further elaborated on in subsection 3.4 on the data analysis process.

In terms of research design, this study entails a multiple-case study (Bryman, 2012). A multiple-case study allows us to find the mechanisms that cause distinctive outcomes in similar contexts, such as the cases of eThekwini and the City of Cape Town. In the next subsection, the case selection and the contexts of the cases are described.

3.2. Case Selection

In this subsection, the decision to analyze eThekwini and the City of Cape Town in this multiple-case study is substantiated. The constitution of South Africa states that the government should provide universal and equitable access to water and sanitation services while protecting and managing the nation's water resources to support sustainable economic and social development (DWS,

2019). Although South Africa is seen as one of the five leading emerging economies globally, and has the largest economy in sub-Saharan Africa, the country is facing difficulties in meeting its promises on water and sanitation services (Vadra, 2017). In 2018, 20% of the population did not have access to safe sanitation, and 36% did not have access to a reliable water supply service.

South Africa is known for its large variety of cultures. From 1948 until 1994, racial segregation was institutionalized in the country by the white population (Reddy, 2016; McFarlane & Silver, 2016). Until the fall of *apartheid* in 1994, the colored and black people had a low social status. They were forced to live in separate townships, were in a separate education system to prepare them for hard labor and were denied voting rights. The effects of *apartheid* are still visible in South African society today. White people dominate the city centers and suburbs, while black people are over-represented in informal settlements. In these informal settlements, only half of the population has access to safe sanitation (DWS, 2019).

Since 1998, the water services authorities are responsible for service provision in South Africa, which in most cases, are the municipalities (Sutherland et al., 2014). Their responsibility is to make sure their services are efficient, affordable, and sustainable. Different municipalities follow different approaches. One of the major issues underlying the failure of many municipalities to provide adequate basic services such as water and sanitation are the political challenges. South Africa is often referred to as a state in *post-apartheid* crisis to highlight it is still dealing with racial segregation (McFarlane & Silver, 2016). After the fall of *apartheid* in 1994, South Africa chose a strong local government system, but the municipalities were not up to the task (Reddy, 2016). One of the major priorities was to improve service delivery, such as sanitation, as large backlogs had developed over time. However, municipalities did not receive enough funding to perform their tasks and heavily depend on grants from the provincial or the national government. This provides room for politicization as the various spheres of government are not necessarily aligned politically. As a result, dysfunctionality in the forms of inability to pass budgets, gain qualified audits, communicate with local communities is widespread across the country.

There are three spheres of government in South Africa, the national, provincial, and municipal government. All spheres have legislative and executive authority in their own spheres. Throughout the government levels, there are two main political parties. The African National Congress (ANC) has been the leading political party nationally since the fall of *apartheid* in 1994, and the Democratic Alliance (DA) was the main opposition party during that same time frame. ANC and DA have been fighting for political power nationally, and also within the biggest provinces and municipalities. Accusations of non-existing or dysfunctional sanitation services have always played a big part during election times.

The two municipalities present very distinctive outcomes, with an international success story for eThekwini and international media attention about protests

regarding decentralized sanitation for the City of Cape Town. Essentially, while the municipalities had similar starting conditions and had to deal with similar challenges, one of the cases turned out to be more successful than the other. The mechanisms leading to these distinctive outcomes are analyzed through a comparative case study.

The location of the two municipalities is displayed in Figure 1. After that, both cases, TIS delineations, and the research timeframe are presented in-depth.

Figure 1. Map of South Africa with eThekwini (blue) and the City of Cape Town (red) highlighted (adapted from Google, n.d.-a, n.d.-b, n.d.-c)

3.2.1. eThekwini Municipality

eThekwini Municipality was formed in 2000 out of seven other municipalities with Durban as its biggest city. As of the census in 2011, it houses 3,4 million people within the province Kwa-Zulu Natal (eThekwini Municipality, 2020). As the name suggests, the majority of its inhabitants speak Zulu. During the time frame of this research, ANC had the majority of councilors in the municipality and surrounding province. Therefore, in eThekwini, all governmental levels are politically aligned.

In eThekwini, the spatial configuration of informal settlements into various rural areas led to the introduction of the Urban Development Line (UDL) (Sim, Sutherland, & Scott, 2016). This spatial planning tool maximizes limited resources by differentiating service levels between the various areas. Areas outside the urban area do not receive full flush toilets with central waste treatment. These rural areas are often serviced with so-called urine diversion

toilets. Urine and fecal sludge are separated at the source to allow for onsite treatment and recycling. eThekwini has been lauded internationally for its inclusive, experimental approach (Sutherland et al., 2014). They took a holistic approach and inspected each step of the value chain, from the user interface to disposal, to iteratively improve the system. The eThekwini Water & Sanitation department (EWS) supports experimental governance and incremental learning by adopting a flexible policy framework, involving communities, and educating citizens on sanitation issues. Additionally, EWS works with many partners such as the University of KwaZulu-Natal and NGOs to create a platform for sanitation innovations, which provides new technologies based on scientific research (Sutherland et al., 2015). Although the spatial structure of the municipality is very fragmented and the number of people living in informal settlements grew by 1% annually on average from 2008 to 2018, the municipality managed to decrease the percentage of households that did not have access to basic services from 30% in 2008 to 18% in 2018 (eThekwini Municipality, 2008; Stats SA, 2019). However, this incremental transformation has also been criticized for creating an uneven distribution of service levels. Spatially dividing the municipality into areas and assigning different service levels to them, increased social segregation (Sutherland et al., 2015).

3.2.2. The City of Cape Town

Before 2000, the area of the City of Cape Town was governed by six independent municipalities with an additional metropolitan council for the whole area (City of Cape Town, 2020). As of 2000, these structures have been merged into one metropolitan municipality. It houses 3,7 million people within the province Western Cape. It is known for its diversity of inhabitants, shown by the fact that the three most spoken languages within the area have an almost equal distribution: Afrikaans, Xhosa, and English. In both the surrounding province and the municipality, DA is the leading political party. Although elections before 2011 were often a very tight race between ANC and DA, DA has had a majority of votes since 2011.

The City of Cape Town chose sewer connections as the standard option since informal settlements are often closer to sewer pipes and treatment works compared to eThekwini, and therefore easier to connect to the central waste treatment (Pan, 2016). Only if the necessary conditions are not met, other decentralized solutions are considered. For instance, the municipality cannot install permanent sanitation in informal settlements located on private land. The City of Cape Town tried various decentralized solutions, thus not offers one specific solution such as the urine diversion toilet in eThekwini. Whereas eThekwini has one governing body for water and sanitation, the City of Cape Town has several units involved in providing basic sanitation services. The Water and Sanitation Informal Settlements Unit is the leading body, but the Human Settlements Unit decides on upgrade planning for informal settlements. Researchers have reported severe internal coordination problems. In terms of strategy, the City of Cape Town tried many decentralized sanitation technologies in informal settlements but could not institutionalize the

knowledge from these experiments, partly due to the high turn-over in personnel. Some community participation has been reported, but this varied from project to project. This led to a low social acceptance of decentralized sanitation solutions (Mels et al., 2009; Pan, 2016). As a result, the average delivery rate of sanitation units equals the informal settlements' growth rate, leading to a more or less stable percentage of 8% of the households not having access to basic sanitation services (Pan, 2016).

3.2.3. TIS delineation

This study considers the municipalities and their developments in decentralized sanitation as two separate TISs because the municipalities' utilities are the main driving actors regarding preferred technologies, pursued processes, and funding. Thus, the main driving actor and vision differ. Furthermore, most actors in each municipality are local or provincial actors, thus only present in one of the two municipalities. However, some actors, such as the national government or private sector companies, participate in both TISs. At the national level, the two TISs share some similar structures in terms of knowledge institutes, funding, and vision provided by national policies.

3.2.4. Research Timeframe

As policies and practices continuously transform, and we wish to analyze the system from the last major change in system elements, the years 2010 up to and including May 2020 have been chosen as the timeframe for this thesis. In 2010, the World Cup took place in South Africa, which led to more ambitious sanitation policies (Du Plessis & Venter, 2010). Promises were made that citizens would experience the economic advantages of the World Cup taking place in South Africa through improved services. In eThekwini, the UDL planning in eThekwini was also introduced in that year, formalizing the type of sanitation services for the various regions (Sim et al., 2016). Lastly, in 2010, the NGO Bill & Melinda Gates Foundation introduced the Reinvent the Toilet project in South Africa, funding and supporting various decentralized solutions (Bond, 2020). These events have led to major structural changes in the decentralized sanitation sectors in both municipalities, leading to the current system structures.

3.3. Data Collection

Data was collected from three primary data sources. First of all, to determine the structure of the decentralized sanitation sectors and their performance, events were retrieved from news articles. These news articles were collected through LexisNexis. With the search criteria set on the name of the municipality plus at least two occurrences of 'sanitation', 252 news articles on eThekwini and 890 news articles on the City of Cape Town were retrieved. Although the initial scanning had shown that approximately 25% of these news articles were indeed relevant for the analysis, stricter search criteria were not applied. Stricter search

criteria turned out to output a higher percentage of relevant news articles but a lower absolute number of relevant news articles. Therefore, the remaining articles were assessed manually. Duplicates, unrelated news articles, tender requests, advertisements, and news bulletins were removed from the list. The final corpus consisted of 198 news articles on the City of Cape Town and 72 news articles on eThekwini. A complete numbered list of news articles is included in Appendix A and Appendix B for eThekwini and the City of Cape Town, respectively. Quotes from news articles in the results section refer to those numbered lists.

Secondly, to get a good overview of (decentralized) sanitation policies, additional data was collected from planning documents by the municipalities and selected reports from consultants and researchers. These were collected through Google Scholar, Web of Science, and Google. A total of 26 documents were identified, consisting of mostly water services development plans and the municipalities' integrated development plans. From these reports, 8 were selected for inclusion in the final corpus, based on information density, even temporal distribution, and an even distribution between the two municipalities. The reports contain 70 to 949 pages with a median of 244 pages. A complete list of reports is included in Appendix C.
Lastly, the findings of this research were triangulated by experts. Through the connections at Eawag and snowball sampling, 11 expert interviews were conducted with 4 government officials, 5 researchers, 1 representative of an NGO, and 1 professional of a private sector company. The interviews were attended through video conferencing and lasted for 30 up to 90 minutes. The interview guide was written based on the news article and policy report analyses and the storylines derived from these analyses. The interviews were recorded and transcribed to be able to analyze them, as explained in the next section. A numbered list of interviewees with their professional role is included in Appendix D. Quotes from interviews in the results section refer to this numbered list. The interview guide is included in Appendix E.

3.4. Data Analysis

In the introduction, four sub-questions were mentioned that collectively answer the overarching research question. This subsection describes how the collected data were analyzed to answer these sub-questions. The first three sub-questions are related to the structures, functions, and institutional work strategies of each TIS. These questions can be answered through the event analysis (Suurs & Hekkert, 2009). The answers to these research questions led to mechanisms that could explain the performance of the TISs, answering the final sub-question. In the following paragraphs, the data analysis process is discussed step-by-step.

Firstly, a database was set up consisting of all the events found in the data in chronological order. A total of 331 events for eThekwini and 984 events for the City of Cape Town were identified. For each event, the actors and institutions

related to it were noted. Networks could be identified by checking which actors often appear in the same events. This answers the first sub-question.

All events were mapped to system functions based on the event typology, as Suurs and Hekkert (2009) suggested. For instance, the system function *guidance of the search* may contain event types such as *positive expectations* and *negative outcomes of studies*. These event types can be assigned a + or - sign based on their relation to the system function. All in all, this led to a list of event types related to each system function with the total number of events and their relation (+ or -) to the performance of the system function. A coding scheme with all event types is included in Appendix F. Based on the event database, trend patterns and interaction patterns were distinguished. Trend patterns can be found by plotting the number of events per year per system function. A sudden change in the slope of the graph suggests turning points within TIS development. After that, the events were related to each other with 'leads-to' relations, which form the interaction patterns. Through this process, a narrative was constructed of the development and current status of the TIS. The time frame was divided into time periods to make it manageable to provide a comprehensive and concise storyline of the developments of the TIS. These time periods were formed based on major pivot points where TIS functions rose or declined sharply, on major contextual developments with influence on the TIS structure, and on changes in system elements. Expert interviews were conducted to triangulate findings, as mentioned in the previous subsection. After transcription, these were also coded based on the seven system functions. The coding scheme is included in Appendix G. With this narrative, it can be assessed how well the system functions are fulfilled in each decentralized sanitation sector, answering the second sub-question.

The third sub-question relates to institutional work strategies used by the actors driving positive or negative TIS development. The legitimation events were further categorized into the various types of institutional work listed in Table 3. If a certain event could not be categorized based on the description of the various types, they were initially coded as uncategorized institutional work. After categorizing these uncategorized codes based on content similarities, eight new institutional work types were distinguished.
Table 4 provides a list of newly identified institutional work types. These newly identified types are elaborated on in the discussion section.

Table 4. Newly identified institutional work types

Type of institutional work	**Description**	**Examples**
Community participation	The inclusion or exclusion of communities in decisions affecting communities	Provide a few options for decentralized sanitation solutions to communities
Disbelief in governmental capabilities	Stating that the government will not be able to fulfill promises due to a lack of capabilities	Doubting alignment between vision and capabilities

Doubting data validity	Doubting the validity of data provided by actors	Doubting sanitation delivery numbers
Framing discourses	Providing frames that give meaning to an issue or solution by connecting theories about what happens and what matters (Druckman, 2001)	Stating that decentralized sanitation solutions are necessary to solve ecological problems or that decentralized sanitation solutions are a form of racial segregation
Legal action	Taking other actors to court over their actions in TIS development	Trying to stop certain development by going to court
Protests	Protests against policies	Protests organized by NGOs and informal settlements
Safety	Focusing on safety aspects	Pointing out uncleaned or vandalized toilets
Creating/ obstructing social acceptance	Support or hinder that other citizens use the provided solutions	Reject solution as community leader

To answer the fourth sub-question, an overview was created representing the interactions between the system structure, institutional work strategies, and performance of the individual system functions. These interaction patterns point to inducement and blocking mechanisms. These mechanisms were checked against the data following the abductive reasoning method to find the best fitting theory for the development of the TISs. By revisiting the data and combining the event analysis data with the expert interviews, the possible mechanisms that led to the outcome of the TIS were substantiated.

3.5. Research Quality

In this subsection, the validity and reliability of this research are discussed, based on the analysis of research quality by Bryman (2012). Validity refers to the integrity of the theoretical conclusions resulting from the thesis. Reliability refers to the extent to which other researchers come to the same findings for these cases following the same methodology. Guba and Lincoln (1994) proposed four quality criteria based on validity and reliability that have been widely accepted for assessing the scientific quality of (multiple) case studies. These criteria are credibility, dependability, transferability, and conformability.

High credibility of the research can be achieved by triangulation. This research's findings were triangulated by experts who are/were active in the TIS of one or both municipalities as a government official, researcher, NGO representative, or private sector professional. Dependability refers to the auditing of the research process, in this case, by dr. Xiao-Shan Yap, who conducted much research in the field of innovation and transition studies and is experienced in the water and sanitation sector in the context of developing countries. Transferability is met if the case studies' findings are related to the contextual uniqueness of the case, allowing other researchers to judge if the results of the research are transferable to other cases. It is necessary to give a full description

of the cases' contexts to achieve this, as provided in this methodology section. The background of the cases is expanded in the results section. Lastly, confirmability is concerned with reaching the highest possible state of objectivity by excluding personal values in the analysis process. This criterium was assessed throughout the auditing process and through the expert interviews.

4. Results

In the first two sections, the TIS structures and developments of eThekwini and the City of Cape Town are analyzed. Afterwards, a comparison is made between the two municipalities in the third section. Lastly, the results are summarized and tied back to the TIS and institutional work theories in the fourth section.

4.1. Development of the TIS of eThekwini

In this section, the development of the decentralized sanitation TIS of eThekwini is analyzed. Firstly, the delineation of the time phases of the TIS is substantiated. Secondly, the structure of the TIS is delineated. Thirdly, the overall development through the TIS functions is examined. Fourthly, the most important events are identified. Lastly, the institutional work is further explored through an analysis of the legitimation events.

4.1.1. TIS Time Phases

As explained in the methodology section, this delineation was derived from major pivot points in the overall development. The first phase, from 2011 to 2013, includes the system building. Through partnerships and knowledge development, the foundation of the TIS was built. From 2014 to 2016, some harvesting could be done building on developed knowledge and legitimacy. The years 2017 and 2018 marked many pilot projects by international actors within the municipality. Lastly, 2019 and 2020 included some political tensions, but also a major project to bring together all insights from previous time periods.

4.1.2. TIS Structure

In this section, the TIS structure is analyzed through the main actors, networks, and institutions.

4.1.2.1. Main Actors and Networks

To discuss the core driving actors of TIS functions, the event shares of the various actor types were calculated. For each actor type, the event share was calculated by summing the number of events it was involved in. After this, the relative shares of involvement compared between the actor types could be calculated. The two graphs in Figure 2 give insight into the main actors driving processes during each time period.

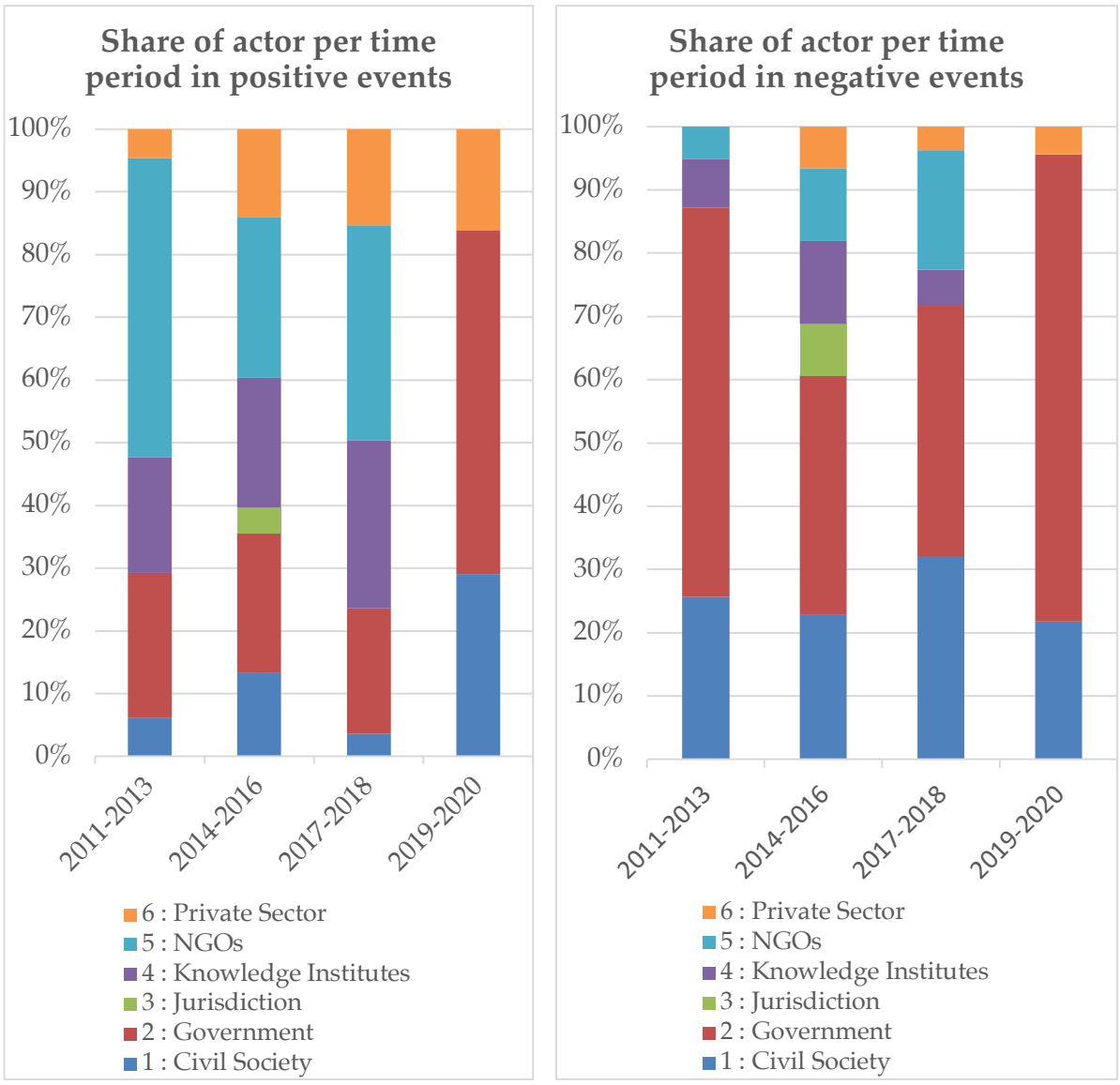

Figure 2. Share of actor types in positive and negative events in eThekwini

The first three time periods, mainly the government, knowledge institutes, and NGOs drove processes leading to positive TIS development, with the private sector getting more involved over time. The final period (2019-2020) is more difficult to analyze as only 11 events could be distinguished from the news articles. Therefore, expert interviews were used as an addition to the events from news articles to analyze this time period.

Regarding the government, mainly the municipal government and specifically eThekwini Water & Sanitation (EWS) was involved (60% of the cases). EWS is responsible for the provision of sanitation services to all inhabitants of eThekwini. They were mainly driving *guidance of the search* (F4) and *legitimation* (F7).

Throughout all events, 16 knowledge institutes were identified. Of the events in which knowledge institutes were involved, the University of Kwa-Zulu Natal

(UKZN) was involved in 33% of them. The University of KwaZulu-Natal (UKZN) in Durban has a significant role in the decentralized sanitation sector of eThekwini. EWS pays a yearly sum to UKZN so that UKZN can bring in scientists from political sciences, biological sciences, agriculture, engineering, social sciences, and more disciplines to assess and improve the approach of EWS. Collectively, EWS and UKZN formed a knowledge network throughout the research timeframe. UKZN was mostly involved in *knowledge development and diffusion* (F2, F3), *guidance of the search* (F4), and *legitimation* (F7). Another important knowledge institute in positive TIS development was Eawag from Switzerland. Eawag led the VUNA research project in eThekwini from 2010 until 2015, which involved researching the various options to recover nutrients from urine and incentivizing urine collection.

Collectively, 14 NGOs were involved in positive TIS development. Of all events in which NGOs participated, the Bill and Melinda Gates Foundation (BMGF) was involved in 56% of them. BMGF is a global NGO that seeks to improve the quality of life, focusing on the areas of greatest needs. Decentralized sanitation in developing countries is one of their strategic pillars. BMGF is a highly potent funder, and throughout the years, they funded a lot of research and pilot projects. BMGF was involved in positive events throughout all TIS functions. They work closely with EWS and UKZN on this topic. EWS, UKZN, and BMGF can be considered a powerful coalition with political power and many financial, human, and intellectual resources. Lastly, the German NGO Bremen Overseas Research & Development Association (BORDA) also played an important role in TIS development. Although BORDA could not be distinguished from the news articles, interviewees mentioned several important events in which they participated. BORDA specializes in sanitation and urban development and focuses on sustainable sanitation solutions. EWS and BORDA have been collaborating since 2005. Among other things, BORDA develops decentralized wastewater treatment systems (DEWATS). In 2020, they started installing these systems in a large re-housing project in the informal settlement Banana City.

In all TIS events, 11 private sector companies were identified. Of these companies, Unilever was the largest. Unilever focuses on providing better sanitation at primary and secondary schools. Also, EOOS from Austria should be mentioned, although they were not identified in the event analysis. According to the interviewees, they were involved in designing better pedestals for the urine diversion toilets. Private sector companies became more involved over time and were most active in *legitimation* (F7), *knowledge diffusion* (F3), and *entrepreneurial activities* (F1).

Events that led to negative TIS development were mainly driven by civil society, supported by various NGOs and political parties. Civil society was most involved in *legitimation* events (F7). 67% of events including civil society led to negative TIS development. Citizens of informal settlements mostly complaint that they were disadvantaged by getting offered decentralized sanitation solutions instead of centralized solutions.

Also, 9 NGOs were involved in negative TIS development. Just as civil society, they were most active in *legitimation* (F7) and focused mainly on the conditions of installed facilities. Lastly, political parties, specifically opponents of the leading political party ANC, were involved in *legitimation* (F7). Especially during election times, the sanitation backlog was used as a political topic.

In comparison to the actors driving positive TIS development, no coalition could be found for actors driving negative TIS development. Part of this could be explained by the large distances between informal settlements, which makes it challenging to organize contestation, but it could also be explained by the fact that these actors driving negative TIS development do not have the same interests and goals. Whereas citizens simply want centralized solutions, NGOs understand the need for decentralized solutions and mostly focus on the types of decentralized solutions used. Lastly, opposing political parties use the issue mostly to attract voters.

4.1.2.2. Institutions

eThekwini has been into ecological sanitation since 2005. Several needs came together during that time. eThekwini has a large rural population that was not connected to formal services or were provided with ventilated pit latrines that were often too expensive to be emptied and therefore abandoned. The large area and long distances between houses disqualified traditional sewer systems as a feasible option. At the same time, rivers were heavily polluted because millions of people dumped their sewage into the environment. On top of that, consistent water supply to these areas remained an issue.

The type of services provided to an area is specified within the Urban Development Line (UDL). This policy provides clear guidelines and prevents the need to inspect each site to list possible solutions and select the right solution for the specific site. From 2002 onwards, eThekwini started experimentation with the urine diversion toilets. Urine and fecal sludge are separated at the user interface. Both waste streams can either be treated on-site or off-site and recycled for re-use. Until today, it remains the main form of sanitation servicing for rural areas. Within more dense areas, communal ablution blocks are used to provide water and sanitation services.

In rural areas, people often use the bushes to go to the toilet. The concrete structure enclosing the urine diversion toilets is often used for other means than sanitation purposes, such as storage space. People that have access to communal ablution blocks often also use a bucket to do their business at home and use the communal facilities to empty their buckets. Although these practices are described in 17 events as consistently happening among many citizens, it is difficult to pin down how many citizens follow these practices exactly.

4.1.3. Overall TIS Development

A total of 331 events were identified for the TIS development of eThekwini. Figure 3 provides an overview of the absolute number of events per system function per year.

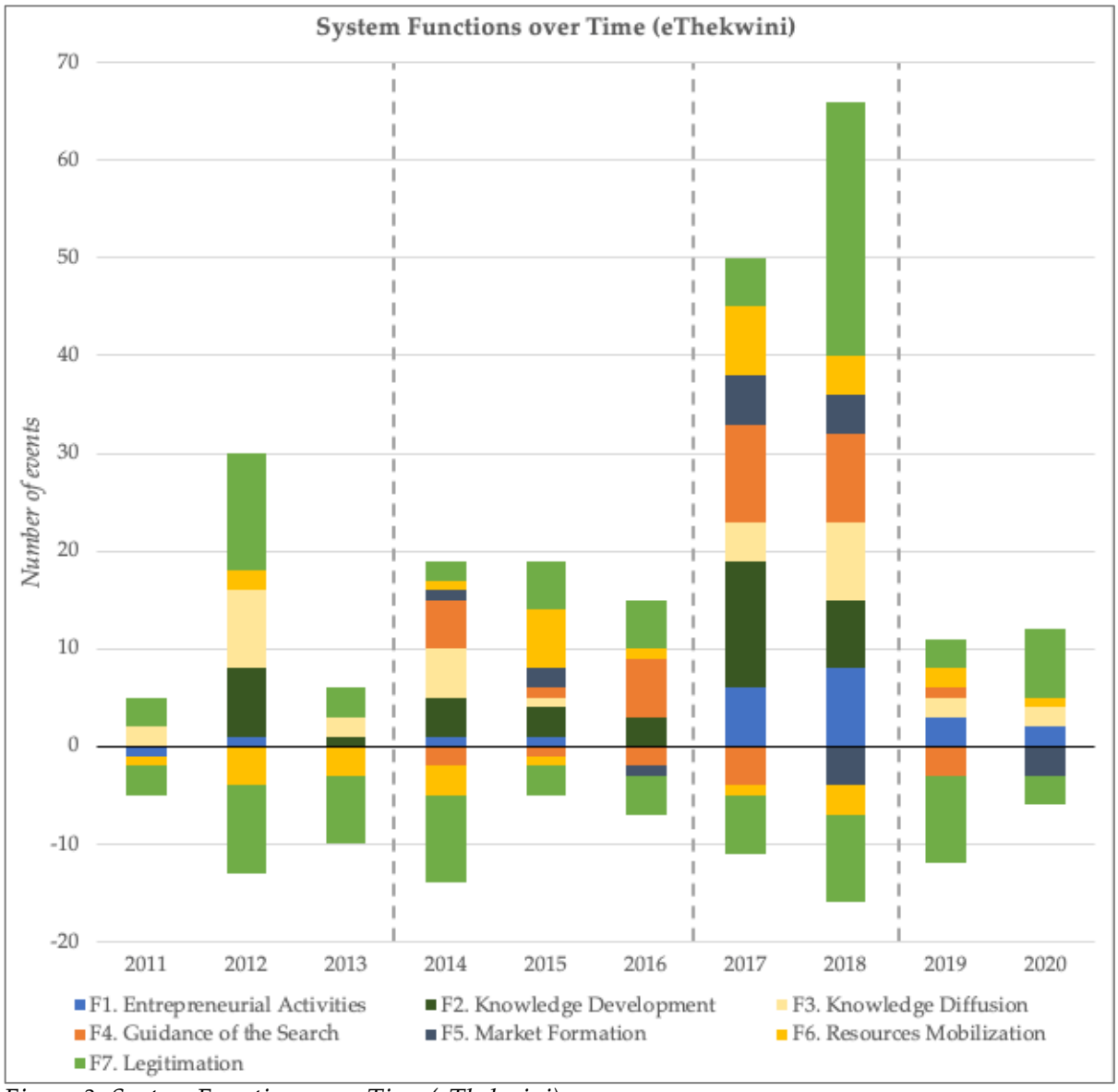

Figure 3. System Functions over Time (eThekwini)

The total time frame was divided into the time periods 2011-2013, 2014-2016, 2017-2018, and 2019-2020. During 2011-2013, a strong coalition of governmental parties, knowledge institutes, and NGOs formed surrounding decentralized sanitation solutions. The coalition's involved parties diffused their vision into a worldwide network of sanitation experts and found each other through shared framings. The main driver of these activities was the NGO Bill & Melinda Gates Foundation that started the Reinvent the Toilet Challenge and funded several knowledge institutes to develop decentralized sanitation solutions. Because of the successful *legitimation* (F7), other system functions such as *knowledge development* (F2) and *diffusion* (F3) were activated. This could be considered the

starting point for the motor of change with *legitimation* and *knowledge development* as the beginning of TIS development.

During 2014-2016, more TIS functions were activated following a 1.6-million-dollar funding from BMGF for the local university UKZN to become the African hub for sanitation research. Through the useful intellectual and financial resources gained in the previous time period, enough legitimacy was generated to be coined as the sanitation center of Africa. During this time period, the individual functions were driven by various actor types. Knowledge institutes became more involved, not only in *knowledge development* (F2) and *knowledge diffusion* (F3) as in the previous time period but in each function. The events with private sector companies involved doubled, following the same pattern as the knowledge institutes. This shows an alignment between these actor types. In comparison to the previous time period, *guidance of the search* (F4), *entrepreneurial activities* (F1), and *market formation* (F5) were activated.

The beginning of the time period 2017-2018 also marked a critical pivot point. The municipality officially announced that they would partner with BMGF and have Durban as the official test site for all new toilet technologies developed through BMGF's funding. This generated a major spike in the number of TIS events. Furthermore, the involvement of private sector companies kept increasing steadily. Also, in 2018 *legitimation* (F7) peaked. Legitimacy was no longer just a *social acceptance* problem. To get the private sector fully involved, *changing normative associations*, and *introducing business-like managerial practice* also became important. Overall, a balanced TIS arose, with all actor types involved throughout all functions.

The period 2019-2020 is marked by a few cracks on the surface. Reports of fraud and corruption endangered the so-far political stability. Nonetheless, EWS, BORDA, and BMGF started a big housing project with state-of-the-art decentralized sanitation in 2020.

4.1.4. Development of Decentralized Sanitation Solutions

4.1.4.1. 2011-2013: System Building Through Partnerships and Knowledge Development

BMGF organized the Reinvent the Toilet Challenge to find decentralized sanitation solutions that are affordable and sustainable to improve people's lives and conserve freshwater for more important means than flushing (F4). According to BMGF, the most important challenges are technological challenges and partnering with governments, businesses, and communities. As water gets scarcer worldwide, no-flush toilets can be a part of the solution to water supply issues. Besides offering social value and environmental impact, it was also seen as a business opportunity (F7). However, citizens were not completely satisfied with the urine diversion toilets installed as a replacement for ventilated pit latrines.

News article E10: "Mnguni believes the beauty of a toilet is it flushing away the waste, taking away the smell. But with these toilets, we live with the dirt, she notes with disgust."

As stated by several interviewees, a full flush toilet is seen as part of modern citizenship. Anything that does not fully flush is automatically seen as an inferior solution (F7).

EWS focused on urine diversion toilets as a solution for rural areas (F4), and UKZN provided the knowledge needed to make necessary improvements (F2) and increase user acceptance (F7). Both the utility and UKZN are keen on partnerships and build their image through visiting conferences and exhibitions. For instance, in 2012, Durban hosted the annual World Toilet Summit, where scientists, experts, and government representatives discussed the future of sanitation (F3). The collaborative approach of UKZN shows through the following quote from the head of the Pollution Research Group at UKZN.

News article E2: "I'm looking forward to the opportunity to meet other researchers and officials responsible for the implementation of basic sanitation systems in different African countries. The opportunity to share experiences and to learn about different situations, opportunities, and constraints will lead to the development of more robust and user-friendly systems."

This strategy paid off. In 2012 it was announced that UKZN was selected by BMGF as one of the eight knowledge institutions worldwide to develop decentralized sanitation solutions. At that time, it was already clear that improving sanitation was not just a constitutional obligation but indirectly would also contribute to other areas of development: reducing healthcare costs, improving productivity, and promoting greater education attainment (F7). It was also clear that they were not developing a sanitation solution just for poor people. In the municipal structure, there was no specific team responsible for sanitation solutions in informal settlements. Instead, solutions were developed in such a way that they would be applicable throughout the municipality (F5).

According to the head of EWS at that time, the reason for rapid progress was twofold: trust with the politicians and confidence in the management team.

Interviewee 1: "One [reason for success] is the mayor. Once we convinced him and had built trust with him, he was incredibly supportive. So, if you have a strong political leader that can lead the politicians and you have a good management team - and I was blessed with an amazing management team - then you can start making things happen."

4.1.4.2. 2014-2016: A Balanced TIS, Time to Harvest

Over the following years, more TIS functions were activated following the system-building of the previous three years. UKZN was appointed by BMGF to become the African hub for sanitation researchers (F2) with $ 1.6 million funding (F6). According to NGOs, these types of partnerships are crucial to experiment (F2) and build a market (F5).

> **Interviewee 10:** "The partnerships have been the key success factor. They partner with UKZN and with BORDA. Through those partnerships, they can get funding from Bill & Melinda Gates Foundation, or the WRC, to fund projects that they would not be able to get themselves if it was just them. So, I think that is their key success factor, it is partnerships."

UKZN became quickly known as the place to research decentralized sanitation solutions. They were known for their safety rating, qualified staff, and long institutional history (F7). This led to new partnerships with knowledge institutes from other countries such as the UK and the US, that started to use eThekwini as the test site for their decentralized sanitation solutions (F3, F5). Furthermore, the private sector became more involved with the help of UKZN (F1). UKZN provided 3D printing services to make quick testing of solutions possible (F5).

> **Interviewee 3:** "If they needed things done in the field, they do not have to get it made somewhere in Europe or the States, get it all finished, and then send it out. If they need something, we can print it overnight and get it done."

However, the primary solution for rural areas, the urine diversion toilets, still suffered from low user acceptance (F7). There was little motivation to use them.

> **Interviewee 4:** "There are trees, there is tall grass. It's not like there is a huge motivation for privacy or safety to go and use a toilet. […] Very few people thought, finally, a toilet seat. So, a lot of them did not use it."

To incentivize the use of these toilets, Eawag collaborated with UKZN in the VUNA project (2010-2015) to test the effects of cash incentives on urine collection (F5). By making the value of urine monetary, citizens would realize that recycling has a specific value to the municipality (F7). Besides that, it would also create an additional income stream for low-income households.

The urine diversion toilet also suffered from other issues with the user interface (F7). It was challenging to separate urine and feces at the user interface, causing urine to get into the feces chamber and feces to clog the urine pipe. Furthermore,

children had difficulties using this type of toilet. To further increase the use of these toilets, the coalition promised to keep improving the user interface over the following years (F5, F7).

4.1.4.3. 2017-2018: Durban as the Test Site for Decentralized Sanitation

The year 2017 was an important year for the decentralized sanitation sector in eThekwini. The municipality announced that they would partner with BMGF to have Durban as the test site for all new toilet technologies developed through their funding (F2, F3). UKZN provided students to work on these projects to ensure that skills would remain locally (F2). An essential aspect of the funding by BMGF was that any intellectual property was openly available to private sector companies, so they could easily jump in whenever a solution was classified as feasible, safe, and desirable (F1). Lastly, to arrive at international standards in this area, BMGF facilitated several workshops in Durban to create international standards for decentralized sanitation systems (F4).

Over the next two years, many technologies were trialed in eThekwini. Five test sites for piloting new technologies were opened with complementary laboratory facilities at UKZN (F2, F5). Solutions such as the Bio-Toilet were trialed, which converts organic waste into cooking fuel and a toilet system with a solar-powered electrochemical reactor to convert human waste into clean water and harmless fertilizer (F1).

The coalition kept putting efforts into gaining international attention. In 2018, BMGF organized an expo to showcase all the decentralized sanitation technologies developed through their funding (F3, F7). To motivate the private sector to become more involved, figures were spread of the potential profit companies could make from decentralized sanitation. It was estimated that the sludge of a community of 1 million people would provide metals with a value of around $ 13 million a year (F7). This figure provides an incentive for engineers to create the best user experience possible and be able to create this revenue stream (F4).

4.1.4.4. 2019-2020: Political Tensions and Banana City

Some profound issues surfaced during this time period. Reports stated that internal tensions within the ANC compromised service delivery in the municipality (F7). An important symptom was delayed projects due to procurement processes, slow decision-making, and poor project management. Accusations were made that contracts were not awarded based on efficiency but based on the benefits the contract could bring to ANC. These political struggles made it more challenging to create a protected space for pilot projects (F5).

However, in 2020, a new big housing project in the informal settlement Banana City has started. It is an integrated approach to housing, in which decentralized sanitation will play a big part. Urine diversion toilets with new, improved pedestals by EOOS will form the user interface, and two DEWATS will be

installed in collaboration with BORDA to treat the sludge on-site. This project allows the municipality to build upon the earlier gained knowledge to set a benchmark for the latest technologies.

> **Interviewee 2**: "For us, it is a complete learning curve, I think for BORDA as well. There is no one else in the world doing this, in terms of from a flushing point of view and collecting the urine separately. For us, it is going to set the benchmark with the parameters of how we start processing nutrients at the end."

4.1.5. Institutional Work

Almost 40% of all identified events were categorized as institutional work. For each event in this category, it was distinguished if the event contributed to (positive) or counteracted (negative) TIS development. In this section, the patterns are analyzed for both positive and negative legitimation events.

4.1.5.1. Institution Work Leading to Positive TIS Development

Table 5 displays all the types of institutional work categorized as contributing to TIS development, divided over the different time phases. To easily see the most important types of institutional work, the cells' background colors correspond to the range of numbers found.

Table 5. Number of institutional work events (positive) in eThekwini

Positive institutional work	2011-2013	2014-2016	2017-2018	2019-2020	Total
Advocacy	2	3	2	0	**7**
Changing normative associations	1	1	7	4	**13**
Community participation	0	0	1	1	**2**
Constructing normative networks	3	1	0	0	**4**
Educating	2	1	2	2	**7**
Framing discourses	10	6	13	3	**32**
Valorizing	1	1	6	0	**8**
Total	**19**	**13**	**31**	**10**	**73**

Overall, the most important actor types driving these processes were NGOs, the government, and the private sector. The most important type of institutional work for positive TIS development was *framing discourses*. Actors give a certain meaning to what has happened and what the important aspects of an issue or solution are. For instance, the success factors of certain pilot projects can be explained in various ways. For some, it was the collaboration with private sector companies that could have contributed to speed. For others, it was the involvement of scientists to make sure the technologies work. In the same way,

problems can also be interpreted in various ways. An often-used argument is that centralized sanitation in eThekwini is not possible due to large distances between houses. Knowledge institutes framed this as a problem that could only be solved by creating a new paradigm for providing services, such as decentralized sanitation services.

> **News article E59**: '"There is no time to build sewerage works, and there needs to be a new paradigm for providing services, such as decentralizing," said Buckley'

Unfolding the *framing discourses* category, we find that 80% of the involved actors are of the coalition EWS, BMGF, and UKZN. Through the media, they consistently tried to legitimize decentralized sanitation by framing the reality in a positive way for decentralized sanitation. This coalition was mentioned a lot by interviewees as the group that drove the positive TIS development.

From 2017 onwards, private sector companies became more involved in TIS development. Looking into the institutional work, we can see that c*hanging normative associations, framing discourses,* and *valorizing* were more prominent in that time period. These processes were driven by the NGOs, government, knowledge institutes, and private sector companies, with the earlier mentioned coalition as the most important driver. An example of institutional work performed by each actor type follows.

NGOs, especially BMGF, were active in *valorizing* by coining their partners eThekwini and UKZN as the leaders in alternative toilet technologies. Furthermore, schools and other organizations in the region received awards for their outstanding performance in providing decentralized sanitation. Internationally, BMGF created legitimacy by organizing events such as the Reinvented Toilet Expo in Beijing in 2018. Again, they emphasized that decentralized sanitation was necessary with the rapid speed at which cities in Africa were developing and that it was an obvious business opportunity to enter this space. In this way, they were also highly active in *changing normative associations.* EWS also did its part in *valorizing*, for instance, by praising Unilever for being a "good corporate citizen" after they got involved in sanitation. They were also active in *framing discourses*. Decentralized sanitation was framed as the solution to health and environmental risks but also as a way to solve other problems with water supply and treatment of human sludge at the same time. UKZN was the most prominent knowledge institute contributing to the legitimacy of the TIS. From a scientific perspective, they argued that there needs to be a mind switch in how sanitation services are designed to better implement concepts of the circular economy in these services. Lastly, the private sector companies also became more involved in these types of institutional work. Private sector companies often need partnerships in the early stages of new technologies. Through communicating business opportunities and potential profitability, they try to create these partnerships.

All in all, a strong coalition of EWS, BMGF, and UKZN was formed in the first time periods. After the technology was at the level to go to scale, these actors performed several types of institutional work to get private sector companies involved. After creating a shared vision, *knowledge development* and *knowledge diffusion* were activated (F2, F3). This vision also provided *guidance of the search* (F4). With the created knowledge and provided vision, private sector companies could perform *entrepreneurial activities* (F1) and test various solutions through *market formation* (F5) in collaboration with knowledge institutes. Figure 4 summarizes the development of driving actors, their institutional work, and TIS functions that were positively influenced by their institutional work.

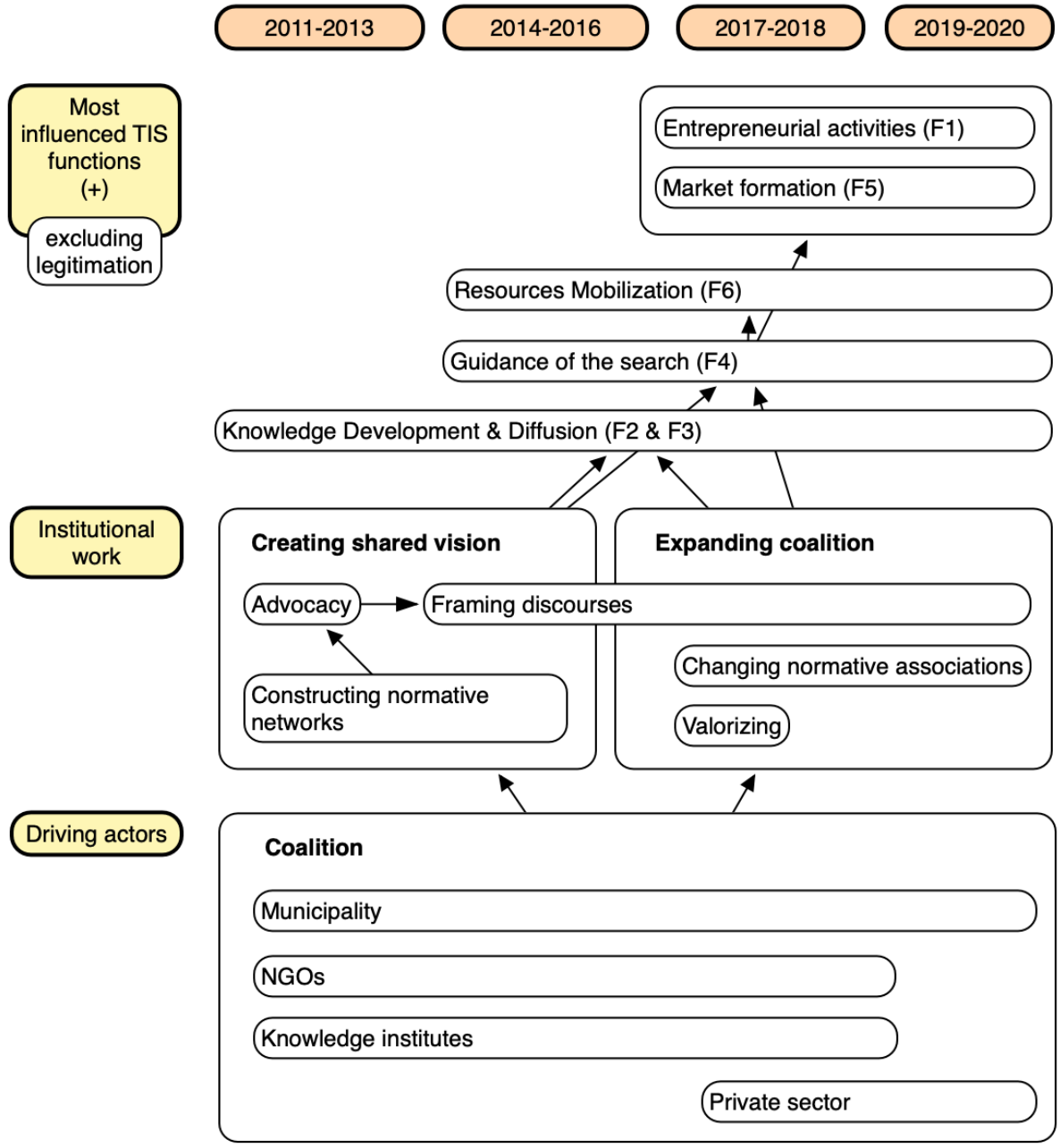

Figure 4. Summary of institutional work by driving actors and most influenced TIS functions in eThekwini

4.1.5.2. *Institution Work Leading to Negative TIS Development*

Besides 73 events related to institutional work contributing to TIS development, 62 events were found that counteracted TIS development.

Table 6 displays the numbers per type of institutional work.

Table 6. Number of institutional work events (negative) in eThekwini

Negative institutional work	2011-2013	2014-2016	2017-2018	2019-2020	Total
Community participation	0	5	1	0	**6**
Framing discourses	3	4	0	0	**7**
Imagery	1	0	0	0	**1**
Legal action	0	0	2	1	**3**
Obstructing social acceptance	3	2	3	1	**9**
Political work	8	2	2	5	**17**
Protests	1	1	0	2	**4**
Safety	3	2	7	3	**15**
Total	**19**	**16**	**15**	**12**	**62**

The most important institutional work types counteracting TIS development were *political work, safety,* and *obstructing social acceptance*. The most prominent actors driving these processes were political parties, civil society, and NGOs. However, there was no stable coalition coordinating these activities.

Political work included events of political parties visiting wards and reporting on the 'shocking' state of sanitation in those wards, often concluding that the leading political party was not handling the sanitation problem well. In the specific historical context of South Africa, the term 'undignified' was often used to resonate with the fact that although *apartheid* has been abolished, the effects of it are still felt in informal settlements. Lastly, political parties accuse each other of corruption.

> **News article E66:** 'Nicole Graham, the party's caucus leader in eThekwini, said: "We have seen basic services being politicized. We have seen contracts awarded not to who can do the work effectively, but to who can benefit the ANC'

Issues around *safety* were mostly brought up by civil society and NGOs. In some cases, this counteracted TIS development as it was stated that these decentralized technologies did not function well, and therefore people were forced to go out in the bushes instead of using a proper toilet. This open defecation was considered to be dangerous, especially for women, as they sometimes get harassed or worse during these trips. It also relates to the design of the pedestals of the urine diversion toilets. It was difficult and sometimes dangerous to use for children.

Obstructing social acceptance was mainly driven by civil society. Individual complaints and issues were reported in the newspapers. However, some news outlets also reported that it seemed that urine diversion toilets had low use rates. The coalition did act upon the most important 'negative' institutional work. Community liaison officers were assigned to individual wards to educate and inform people and ensure that the municipality is communicating effectively with citizens. Issues brought up by civil society and NGOs were not ignored but discussed with the citizens and NGOs involved in the complaints.

> **Interviewee 4:** "Each of us had a big team of community liaison officers. Their job, which I did not understand for a long time, was just driving around chatting to people. It was not until later that I understood, you are the face of EWS. They are literally just chatting to people, chatting to councilors. If there's a problem, someone has a chat. [..] And I think they spend a lot of money on those people. And I think it has really paid off."

The combination of the institutional work types counteracting TIS development had limited impact. Institutional work mostly influenced *guidance of the search* (F4) and *market formation* (F5) negatively. *Political work* led to low expectations and doubt (F4), low *social acceptance*, and doubts about *safety*, which counteracted the formation of a protected space to experiment with decentralized sanitation solutions (F5). Figure 5 represents the main opposing actors, their institutional work, and their influence on TIS functions.

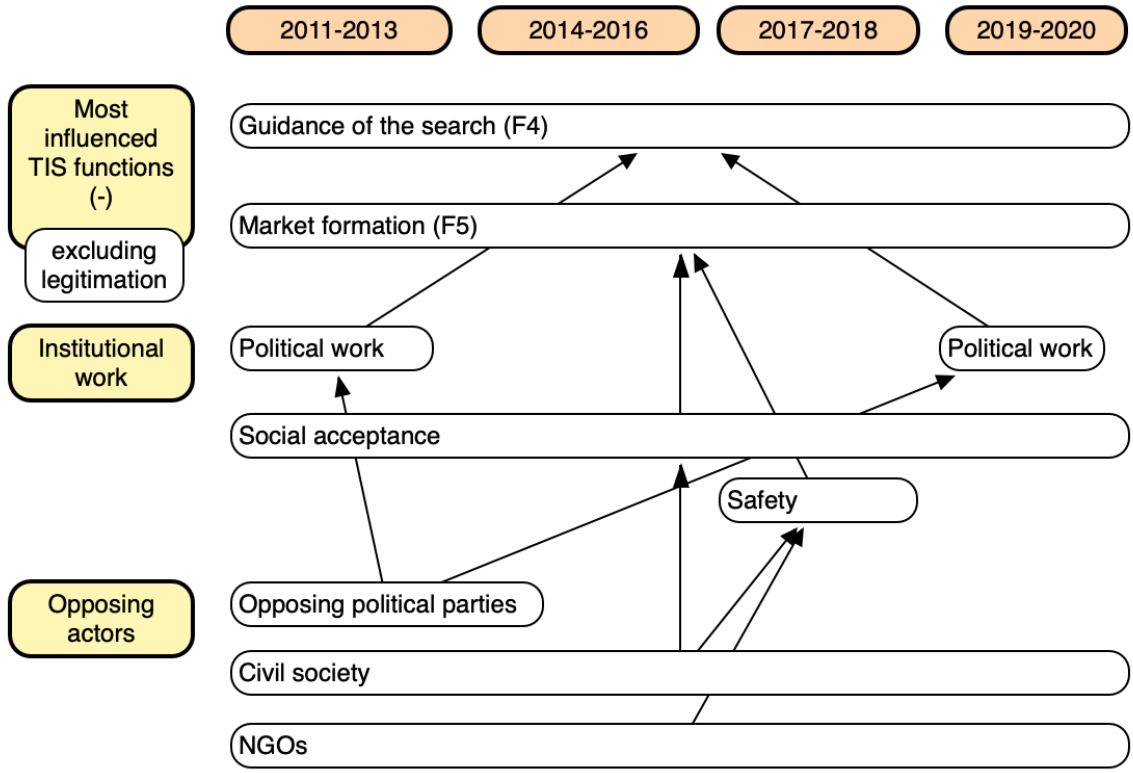

Figure 5. Summary of institutional work by opposing actors and most influenced TIS functions in eThekwini

4.2. Development of the TIS of the City of Cape Town

In this section, the development of the decentralized sanitation TIS of the City of Cape Town is analyzed following the same pattern as in the preceding section.

4.2.1. TIS Time Phases

The first time phase, 2011 and 2012, was marked by citizens' complaints and collaborations between actors to solve these issues. After that, in 2013 and 2014, political work and protests suppressed further TIS development. The last time period, from 2015 to 2020, was marked by little development in decentralized sanitation solutions and the struggles of the municipality to achieve progress in this matter.

4.2.2. TIS Structure

4.2.2.1. Main Actors and Networks

Just as for eThekwini, the event shares per actor type throughout the time periods are analyzed. The two graphs in Figure 6 give insight into the main

actors driving processes during each time period. The time periods are elaborated on in the next section.

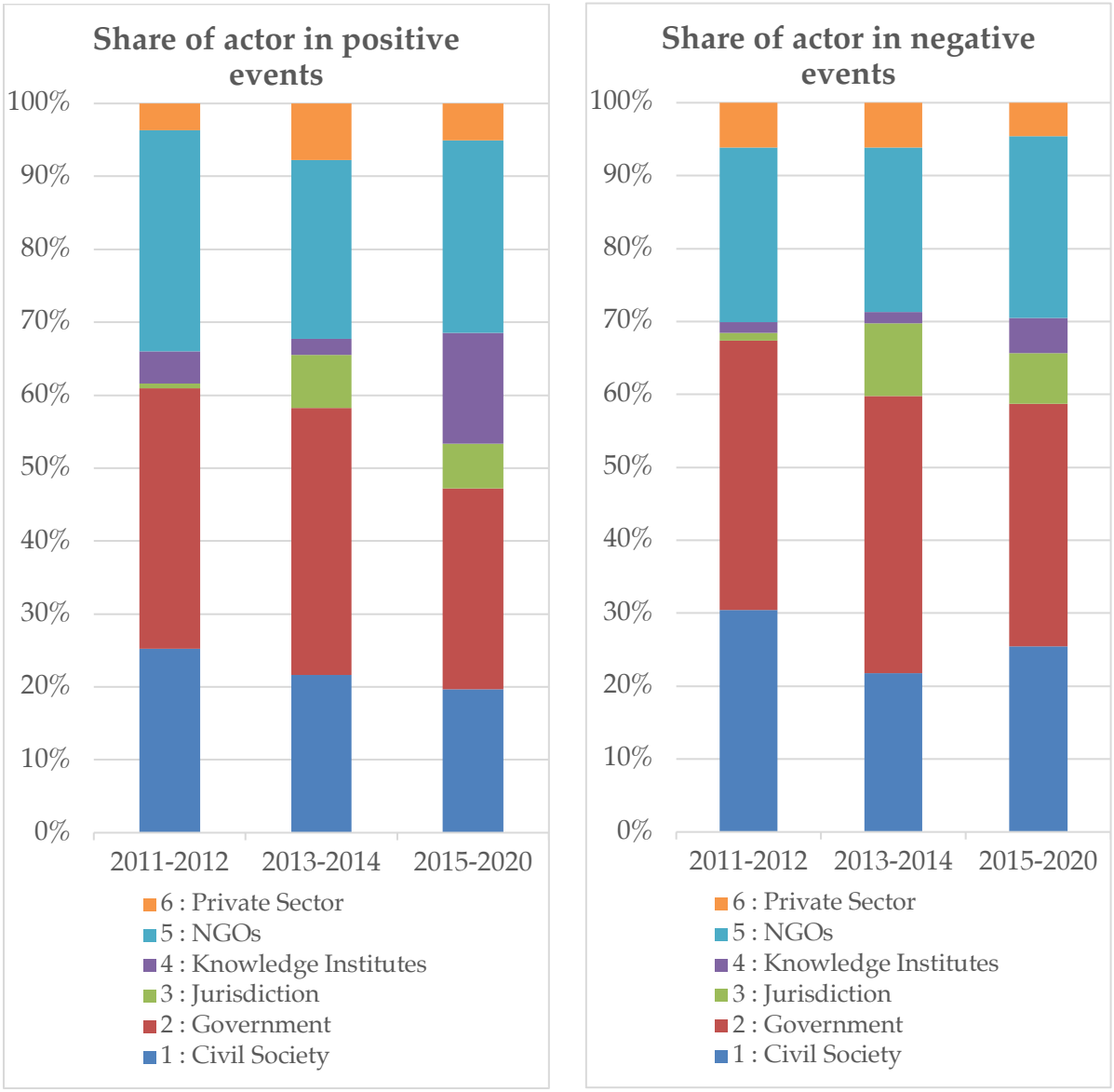

Figure 6. Share of actor type in positive and negative events in the City of Cape Town

The actor event shares were relatively stable, both for positive and negative events. Furthermore, actor type division driving positive TIS development was very similar to the actor type division driving negative TIS development. Therefore, the most important actor types are unfolded to distinguish which actors were involved in which development. The three most important actor types were the government, civil society, and NGOs. Knowledge institutes became more active in the final time period and are also analyzed.

The government was mostly involved through the municipality and political parties. Both the municipality and political parties mostly focused on *guidance of the search* (F4) and *legitimation* (F7), just as in eThekwini. Civil society's role was centered around the informal settlement Khayelitsha. Khayelitsha is the largest informal settlement of Cape Town, with 400,000 inhabitants. Although

many housing projects were finished in recent years, it is still a very low-income area with an unemployment rate of 70%. Inhabitants of Khayelitsha were mostly involved in *legitimation* (F7) but also focused heavily on *guidance of the search* by trying to influence the municipality's policies. A similar pattern of one dominant actor within an actor type can be distinguished for the category NGOs. Although 13 different NGOs were identified in the event analysis, 77% of the events in which NGOs participated, the Social Justice Coalition (SJC) was the involved NGO. SJC was formed in 2008 in Khayelitsha, and as of 2009, it focuses on clean and safe sanitation. Their goal is to make sure each citizen has a dignified toilet, preferably a full flush. SJC was mostly involved in *legitimation* (F7) and *guidance of the search* (F4). Looking at the NGOs' overall contribution, 62% of the events NGOs participated in were related to negative TIS development. Lastly, a total of 10 knowledge institutes were identified. In comparison to eThekwini, there was not one specific knowledge institute more involved than others. Knowledge institutes focused on *legitimation* (F7) to push positive TIS development and *developed and diffused knowledge* (F2, F3).

There was no stable network driving positive TIS development in the City of Cape Town. The municipality mostly formed partnerships on a project basis. During the first two years, a short collaboration was formed between SJC and the municipality, driving some positive developments. However, from 2013 onwards, this relationship was damaged by conflicting interests, which is further described in the overall TIS development section. Civil society and NGOs, especially Khayelitsha and SJC, did form a partnership opposing decentralized sanitation solutions. Collectively, they performed institutional work to delegitimize decentralized sanitation solutions (F7) and guide the municipality towards more centralized solutions (F4).

4.2.2.2. Institutions

In the City of Cape Town, the type of sanitation service offered depends on the topological conditions, economic feasibility, available space within the settlement, and land ownership. Waterborne sanitation is the preferred solution but can only be constructed when the land is owned by the government, and sewer connection is within economic distance. These waterborne solutions are often shared services with ratios of one facility per 5 up to 25 households. In all other combinations of conditions, container types or types of dry sanitation are used. The exact solution within these types of sanitation is chosen based on a catalog. Companies and NGOs can pitch their sanitation solutions to the municipality. If an assessment team considers the solution technically adequate and feasible, it is included in a catalog. From this catalog, engineers and project managers can choose an appropriate solution for specific sites in consultation with residents. As of 2014, the City also offers portable flush toilets to individual households whose only other option is a shared sanitation service.

In terms of practices, citizens who only have access to a shared service often relieve themselves outside. Shared services often get vandalized, and therefore these containers are locked. It is often difficult for people to find the person in

the community who currently possesses the key. Also, some families claim shared toilets by not sharing the keys. Before the introduction of portable flush toilets, people often used buckets at night because they felt it was too dangerous to go outside during the night.

4.2.3. Overall TIS Development

A total of 984 events were identified for the TIS of the City of Cape Town. Figure 7 provides an overview of the absolute number of events per system function per year.

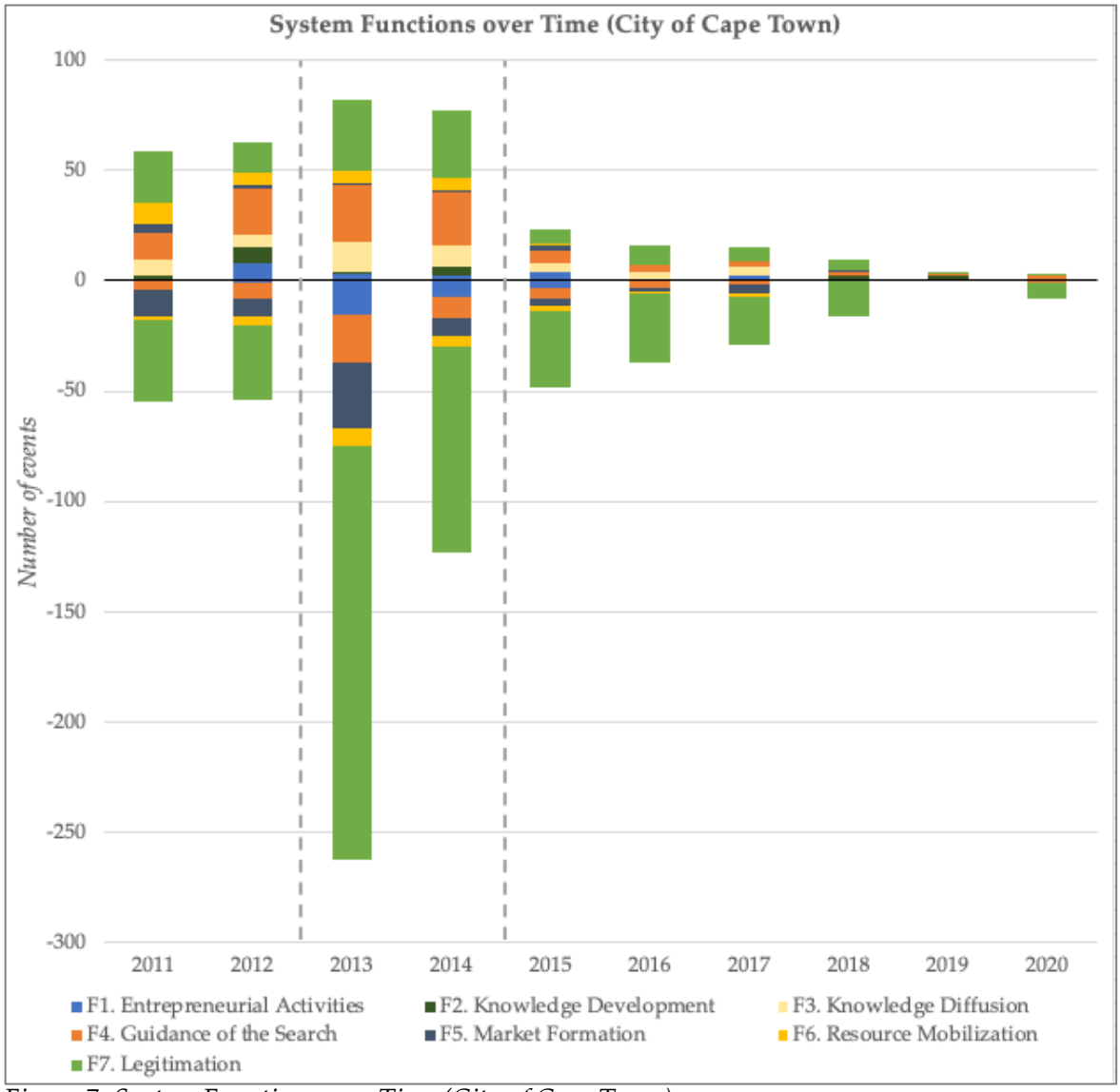

Figure 7. System Functions over Time (City of Cape Town)

The individual time periods are 2011-2012, 2013-2014, and 2015-2020. The first time period included a collaboration of the municipality and SJC. SJC started to represent citizens of informal settlements in sanitation issues. As a community organization, they can motivate citizens for specific goals. However, they might not necessarily be aligned with what is framed as a positive contribution to the TIS development of decentralized sanitation, as they often advocate for full

flush toilets in informal settlements. Looking into the individual functions, *legitimation* (F7), *guidance of the search* (F4), and *knowledge diffusion* (F3) were most reported on in terms of positive development. This pattern continued throughout the other time phases. In terms of negative development, *legitimation* (F7), *market formation* (F5), and *guidance of the search* (F4) were most reported on, which was also the case in the subsequent time periods.

The years 2013 and 2014 were marked by many negative legitimation events due to clashes between the City of Cape Town's leading political party DA and the nationally leading political party ANC during the election time for the national and provincial government. This time period was marked by *political work* and *protests* and shows that TIS development is difficult when strong political forces clash. The municipality took a very defensive stance and mostly neglected or denied the issues that NGOs, society, and opposing political parties raised, which eventually led to more protests.

A halt in many TIS functions defined the time period 2015-2020. Many TIS functions were (almost) absent, and negative legitimation activities remained. Collaborations with knowledge institutes and NGOs were difficult to achieve. Furthermore, many external shocks influenced TIS development. The drought and Covid-19 shifted to focus from sanitation to water supply. Departments at the municipality that previously dealt with both water supply and sanitation shifted their focus to water supply. With an already dysfunctional TIS in place, this reduced the ability to innovate even more.

4.2.4. Development of Decentralized Sanitation Solutions

4.2.4.1. 2011-2012: Complaints and Adequate Responses

In terms of TIS functions, 2011 was a relatively good year: *knowledge development* (F2) and *knowledge diffusion* (F3) were activated through the collaboration between the SJC and the municipality. Lots of promises were made, and expectations were high (F4). The municipality attended the Cape Town Sanitation Summit, organized by SJC. It was announced that the municipality would introduce a janitorial services project to deal with the complaints that toilets in informal settlements were not serviced well or dysfunctional (F6, F7). The municipality would employ 8,000 previously unemployed people from informal settlements to clean and maintain communal toilets within informal settlements. This creation of jobs contributed positively to another issue in society.

> **Interviewee 5:** "Another big point of contention that is a politicized issue is jobs. There is a huge hunger for jobs in areas with super high unemployment. Some of the settlements officially have over 50 percent unemployment, but people have informal ways of hustling, but it is not a job."

SJC and other NGOs were very optimistic about the developments these first two years. However, in hindsight, it turned out to be of short duration.

> **Interviewee 10:** "It goes through stages. Between 2006 and 2012, we [NGO] had a far better relationship with the City of Cape Town because the officials were more pro-poor and more open to putting forward the agenda of community participation and community engagement and new ideas. For the last eight years, they have just been cut and paste and just done things the conventional way."

Political work had a significant influence throughout the years (F7). The Youth League of the political party ANC took the DA-led municipality to court over the installment of unenclosed toilets. Also, reports came out on the underspending of sanitation budgets, while at the same time, the City of Cape Town claimed there were not enough resources available (F6), leading to negative expectations (F4).

After the start of the janitorial services project, it quickly became apparent that this would not eradicate the problems with the availability and cleanliness of toilets altogether, as for instance, it was fairly difficult to find broken toilets in an informal settlement. To deal with this issue, the municipality organized a sanitation hackathon that outputted mostly apps to rate services and notify the municipality about dysfunctional toilets through GPS (F2, F4). The need for decentralized sanitation solutions was lower, as the area is denser, and sewer connections are often within a short distance of the informal settlement (F4). The need for decentralized solutions was limited to informal solutions located on private land where it is impossible to provide permanent solutions or areas prone to flooding (F4).

> **Interviewee 5:** "There are settlements here that have existed for more than ten years on privately owned land. Nothing can be done. So, for ten years, we have been spending money on those settlements, money for which we could have maybe installed more permanent services. In some of these settlements, bulk infrastructure is not that far. We can extend the sewer line to install more permanent services. The policy says you cannot install permanent services on privately owned land. So, these are the things that need to be looked at because they do not make economic sense."

4.2.4.2. 2013-2014: Protests and Political Work

The year 2013 was the year before the national and provincial elections. ANC, the main opposition party in the province and the leading political party nationally, took sanitation as their main campaign issue. SJC and various other NGOs hopped onto the wagon, which resulted in a lot of *political work* and *protests*, halting TIS development (F7).

The municipality introduced the portable flush toilet to eradicate the black buckets, of which a few hundred still circulated in the informal settlements, and to provide citizens whose only alternative is a shared service, with an individual toilet (F4). Any citizen who would make a request could get one of these portable flush toilets.

The *social acceptance* of this solution was very low (F7). Communities complained they were not involved in this decision. Furthermore, they claimed the toilets were smelly, the toilets' servicing was bad, and they quickly broke. Therefore, some communities rejected the portable flush toilets, even when a black bucket was their only alternative. However, their motivation for rejecting the solution could also be a micro-political issue.

> **Interviewee 6:** "You have a DA-controlled government and an ANC-minority government, the latter of whom is especially active as local representatives and influential of community leaders in informal settlements. Even though the bulk of residents might be happy with the services and satisfied with the improvements, that minority might have an especially strong voice given their partisan stance in opposing the majority government. In other words, city officials often said there was no way to win because their 'DA-sanitation interventions' would always be painted negatively by the ANC-minority in the press."

There was also doubt about the positive figures that the municipality spread about their sanitation services (F7). SJC organized a social audit to assess the state of toilets in informal settlements (F3). According to their data, 25% fewer toilets existed in reality than in the official numbers. Furthermore, of these toilets, 50% were in an unusable state, either locked or damaged. Lastly, around 70% of the toilets were cleaned at least once a week, while all toilets should be cleaned three times a week. After attending the public hearing about this audit, the municipality stated that a lack of technical, contextual, and historical understanding by SJC could be derived from their audit. The municipality rejected the findings and claimed that the SJC was hostile against the government and would not collaborate anymore.

A year of *protests* followed (F7). SJC organized some peaceful protests, but the Youth League of ANC took a different approach. Feces were dumped at the airport and government buildings and thrown at the mayor. This generated worldwide media attention. They also claimed that they would make the municipality ungovernable if it would not develop a decent sanitation plan.

Amidst all this, little positive development was possible. However, in 2014 the World Design Capital was organized in Cape Town with a Better Living Challenge Showcase to demonstrate design solutions to informal settlements challenges (F3). Among the prototypes, a self-contained private composting toilet was shown.

4.2.4.3. 2015-2020: Innovation Comes to a Full Stop

During this last time period, many TIS functions came to a halt. Although the number of protests went down, *legitimation* remained an important issue with many negative events related to a lack of *social acceptance*, lack of *community participation*, and *political work* (F7).

An example of this *political work* was the political storm that followed after a national audit in 2015. This national audit reported that 700 million rands of allocated funding (almost 37 million euros) were not spent on sanitation between 2010 and 2013 nationally. DA used this report to show their superiority in the percentage of citizens that do have access to flush toilets in their municipality (90%) and stated that they did well compared to other ANC-municipalities with lower numbers (F7).

Collaborating with the municipality remained difficult. According to researchers, it was difficult to collaborate with the City of Cape Town on sanitation projects as a knowledge institute.

> **Interviewee 6:** "I did not note knowledge institutes having an integrated role at the City of Cape Town as you would find in eThekwini. There are three universities in Cape Town. From my knowledge of the five years I was there, none of them had a formalized and established water and sanitation partnership in terms of scale as UKZN and eThekwini. I observed that representatives of government, private service providers, community representatives, and social advocates at NGOs had far more prolific and influential roles when it came to be contributing to sanitation processes and policies at a local level and at scale."

The relationship between the municipality and NGOs remained difficult. In 2016, when the municipality asked for input on their draft budget, SJC handed over their comments after a march to the mayor's office. According to SJC, they never received a response, indicating that the municipality did not take citizens from informal settlements seriously (F7).

Although the City of Cape Town had already been dealing with drought for years, in 2018, the drought truly became a big issue when Day Zero was announced. Day Zero would be the day that no water would be running from the taps anymore. Therefore, citizens had to ration their water. In the end, Day Zero was avoided, but water supply remains an issue, a more pressing issue than sanitation was at that time (F7).

In 2020, another external shock took place with the Covid-19 situation. A full lockdown was announced, but most citizens in informal settlements have to go out to get water and to go to the toilet. Sharing these facilities and a lack of access to health services made them more vulnerable to the coronavirus than other

citizens (F7). The municipality set up project teams to ensure the most vulnerable citizens would keep access to water supply and sanitation (F4).

One final external shock to mention, one that actually could speed up progress, was the announcement of the landfill ban (F4, F7). The province Western Cape announced a ban on organic waste to landfill by 2027, with a 50% ban by 2022. This creates the need to better process human sludge to avoid the need to dump human sludge through pipelines in the sea, which causes international friction. One of the private sector companies looking into alternative use cases for human sludge was optimistic about the technological ability to do so, but bureaucracy slows down progress.

> **Interviewee 11:** "They are very siloed, no one talks to each other. To get a research project going, you have to go through a number of bureaucratic channels. So, you talk to certain people, but they have to go through a whole number of networks to get to something that should be quite simple to do. It is just about bureaucracy, really."

4.2.5. Institutional Work

Almost 60% of the events, were categorized as institutional work. Just as with eThekwini, the patterns will be analyzed for both positive and negative events.

4.2.5.1. Institution Work Leading to Positive TIS Development

Table 7 includes the types of institutional work that contributed to TIS development.

Table 7. Number of institutional work events (positive) in the City of Cape Town

Positive institutional work	2011-2012	2013-2014	2015-2020	Total
Advocacy	8	1	1	**10**
Changing normative associations	1	10	13	**24**
Community participation	12	21	7	**40**
Constructing normative networks	0	1	0	**1**
Creating social acceptance	2	1	0	**3**
Educating	3	10	3	**16**
Framing discourses	10	15	3	**28**
Mythologizing	0	2	0	**2**
Valorizing	2	2	1	**5**
Total	**38**	**63**	**28**	**129**

Throughout the years, *community participation*, *framing discourses*, and *changing normative associations* contributed most to positive TIS development. The government, NGOs, and civil society were most involved in positive institutional work. In comparison to eThekwini, little *advocacy* and almost no

constructing normative networks were reported. Indeed, by unfolding the different types of institutional work and looking into which actors drove the processes, it can be concluded that there was no stable coalition of various actor types that drove positive TIS development. During the first time period, 2011-2012, *advocacy* was reported through a collaboration between the NGO SJC and the municipality. However, from 2013 onwards, this relationship deteriorated.

Community participation was mostly a collaboration between the NGO SJC and civil society. For instance, social audits, counting, and reporting sanitation facilities and assessing their current state was a collaboration between these actor types to drive positive TIS development. SJC also represented civil society in their conversations with the municipality. Thereby, they brought issues with facilities to the foreground.

Framing discourses surrounds the various interpretations of projects by the City of Cape Town. The government was most active in this category. The City of Cape Town mostly focused on the constraints to justify their strategies.

> **News article C85:** "The City of Cape Town is unable to install infrastructure for basic services in most of the informal settlements because they are located on unsuitable land."

Changing normative associations activities were mostly driven by the municipality surrounding the introduction of the portable flush toilet. The municipality tried to combine the need for decentralized sanitation solutions with the idea of a flush toilet to create more social acceptance of these solutions.

All in all, there was no stable coalition driving positive TIS development. Nonetheless, *community participation* and *framing discourses* led to positive events for *knowledge diffusion* (F2) by education and events and *guidance of the search* (F4) by making promises and creating positive expectations. Figure 8 summarizes the development of driving actors, their institutional work, and TIS functions positively influenced by this institutional work.

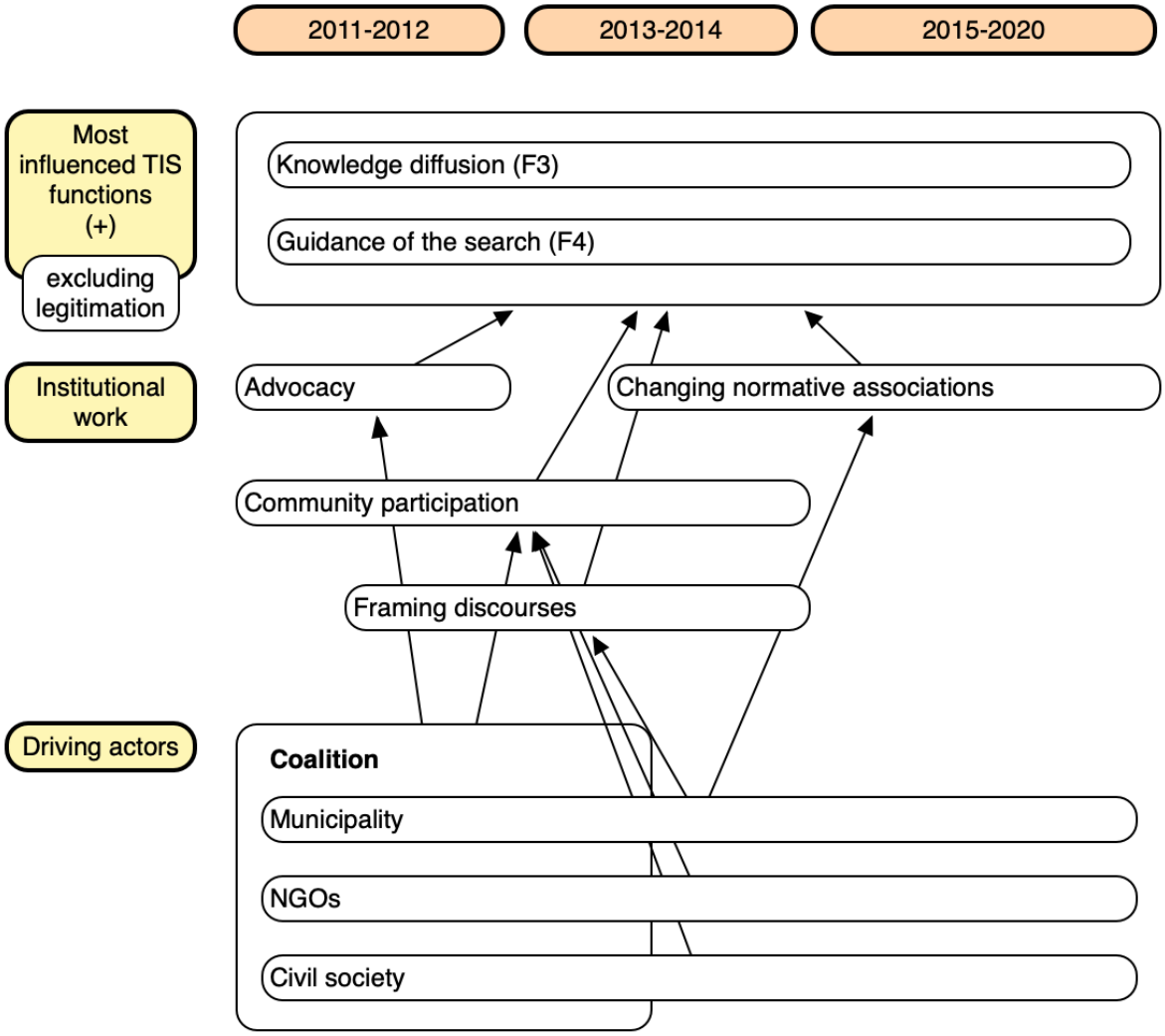

Figure 8. Summary of institutional work strategies by driving actors and most influenced TIS functions in the City of Cape Town

4.2.5.2. *Institution Work Leading to Negative TIS Development*

Besides 128 events related to institutional work contributing to TIS development, 461 events were found that counteracted TIS development. Table 8 presents the number of events in the various categories of institutional work counteracting TIS development.

Table 8. Number of institutional work events (negative) in the City of Cape Town

Negative institutional work	2011-2012	2013-2014	2015-2020	Total
Advocacy	2	12	6	**20**
Changing normative associations	1	3	1	**5**
Community participation	5	31	11	**47**
Constructing normative networks	1	0	0	**1**
Demonizing	1	1	0	**2**
Disbelief in governmental capabilities	2	6	3	**11**
Doubting data validity	7	26	3	**36**
Framing discourses	6	10	1	**17**
Imagery	6	6	12	**24**
Legal action	2	34	15	**51**
Mythologizing	0	6	3	**9**
Obstructing social acceptance	3	30	16	**49**
Political work	11	58	13	**82**
Protests	20	62	17	**99**
Safety	12	21	21	**54**
Total	**79**	**306**	**122**	**507**

Overall, the government, NGOs, and civil society were mostly driving these processes. *Protests, political work, legal action, obstructing social acceptance, community participation,* and *doubting data validity* were the most important counteracting types of institutional work. Although there was no stable coalition driving the contributing institutional work, the counteracting institutional work was mostly led by a few NGOs in combination with the political party ANC and civil society.

Most of the *political work* focused on the increasing sanitation backlogs and undignified circumstances surrounding sanitation facilities in informal settlements.

> **News article C6:** "Unlike the DA, the ANC will never justify nor defend the non-provision of decent sanitation to our people," the ANC said.
>
> Nkenke Kekana, the ANC's Gauteng branch spokesman, said the apartheid-era bucket system dehumanized people."

Note that the province Gauteng is led by ANC, the largest opposition party in the province Western Cape and the City of Cape Town. To illustrate the political fight happening throughout the years, another quote is added below from the opposing political party DA.

News article C55: "On top of that, the City of Cape Town is the best performing metro at 97.2%. So the question is, why is the ANCYL [ANC Youth League] protesting in Cape Town - which has the best sanitation in South Africa - and not in the rest of the country, where millions of people are forced to use buckets as toilets? […] Instead of flinging feces around, the ANCYL should be focusing on holding its governments to account for their 19-year failure to deliver proper sanitation in the rest of the country."

Protests were also widespread, especially surrounding the national and provincial elections in 2014. ANC, the main opposition party in the surrounding province Western Cape, made sanitation one of the election's main topics. ANCYL and SJC were the main organizers of these protests. Although SJC organized various peaceful protests, other actors used different methods to create worldwide attention.

News article C63: "On Monday, former ANC councilor Andile Lili and others were arrested on their way to dump feces, and other refuse outside the City Council and Legislature. A week before, Lili and ANC Youth League (ANCYL) member Loyiso Nkohla emptied portable toilets filled with human waste on the steps of the provincial legislature. Protesters in Khayelitsha threw human waste on a vehicle that Western Cape Premier Helen Zille had been traveling in while she attended a meeting in Khayelitsha."

Although the number of protests went down after the elections, they remained the main communication channel of NGOs and civil society with the municipality, blocking the opportunity for dialogue and positive TIS development.

Legal action was also taken by actors to slow down decentralized sanitation development. Especially political parties and NGOs used this type of institutional work. Furthermore, the Human Rights Commission (HRC) also contributed to this by taking the municipality to court about the portable flush toilets. According to HRC, this decentralized sanitation solution was an example of ongoing racial segregation by not offering informal settlements, mostly black people, the same services as the formal settlements. NGOs helped informal settlements start court cases about unenclosed toilets, broken toilets, and the often-interrupted maintenance of toilets.

Obstructing social acceptance was mostly driven by civil society and NGOs. Inhabitants of informal settlements often rejected newly offered solutions and opted to keep using the bucket system until a full flush centralized system would be installed. According to them, all these solutions should be temporary, but for most of these solutions, contracts are signed with service providers for ten years of maintenance.

News article C73: '"The City of Cape Town municipality has placed more than 11,000 toilets in different areas in Khayelitsha. People are complaining that the toilets are not being cleaned. Nor are they safe and dignified," said Axolile Notywala of the SJC.'

Another often-heard complaint is the lack of *community participation*. NGOs and civil society often feel left out in important decisions that affect the community. Furthermore, community initiatives, such as the social audit discussed in the previous section, got rejected by the municipality.

Lastly, NGOs, civil society, and the opposing political party ANC often doubt the *validity of data* provided by the municipality. According to the municipality, 250,000 households did not have access to sanitation in 2011. However, research by NGOs found 500,000 households without access. According to NGOs, the municipality performs inadequate maintenance and monitoring, and due to that, many toilets are broken or permanently closed. NGOs think these toilets are taken into account when calculating the number of households serviced. This leads to a further strained relation between the municipality on the one side and civil society and NGOs on the other side.

All in all, these institutional work strategies mostly influenced *guidance of the search* (F4) with negative expectations, doubt, and unmet promises. Also, *market formation* (F5) got particularly difficult as the municipality could not provide protected spaces for experiments with new solutions since all experiments were directly contested by opposing political parties, civil society, and NGOs. Figure 9 represents the main opposing actors, their most important institutional work, and their influence on TIS functions.

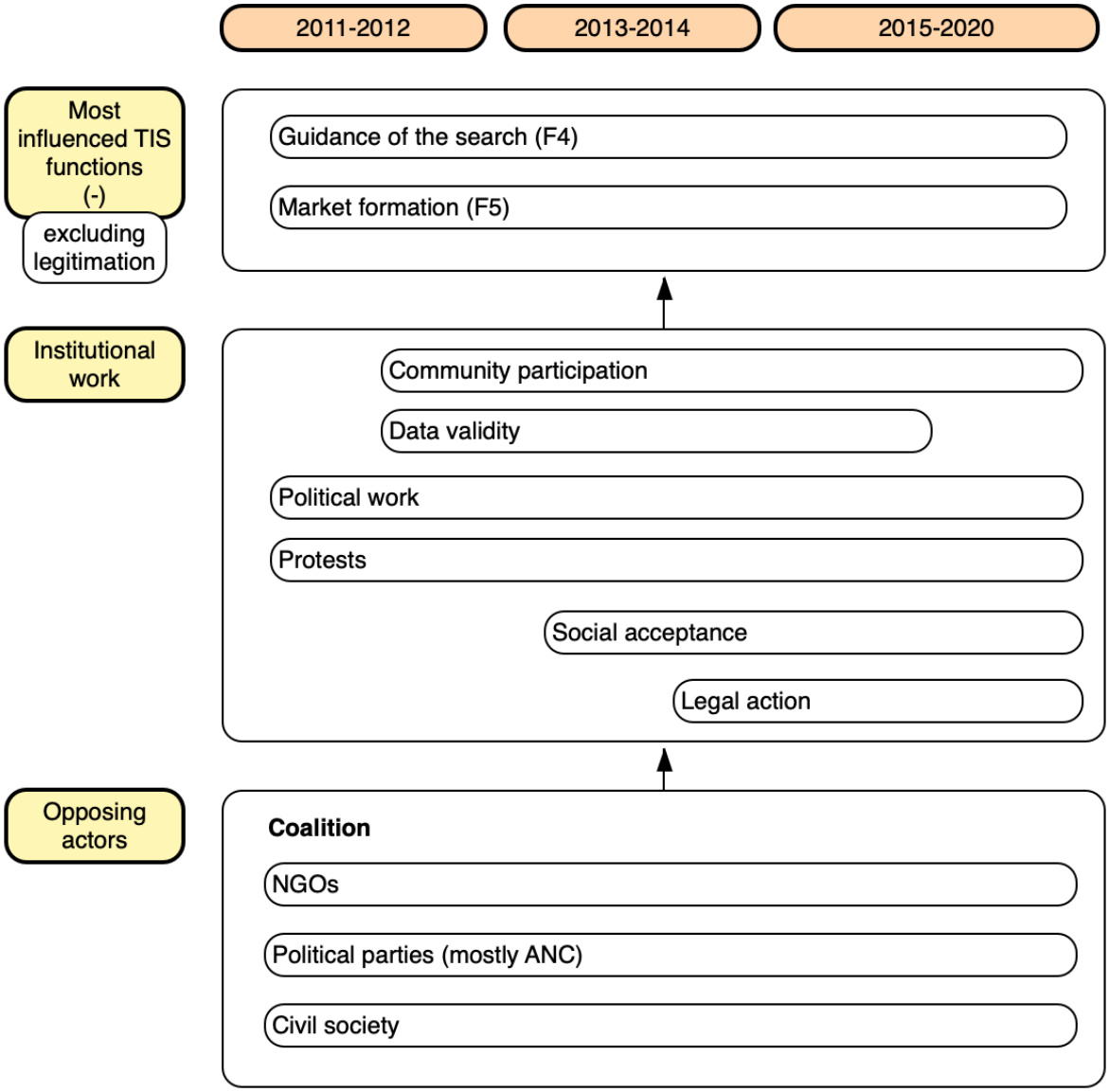

Figure 9. Summary of institutional work by opposing actors and most influenced TIS functions in the City of Cape Town

4.3. Comparison Between the Two Municipalities

The two municipalities are systematically compared through the most important actors, coalitions, and institutional work strategies.

4.3.1. Most Important Actors

An important difference between the two municipalities is the involvement of knowledge institutes. In eThekwini, through a continuous partnership with the municipality, knowledge institutes created a continuous stream of necessary intellectual assets. In the City of Cape Town, knowledge institutes were barely

involved, and when they were involved, it was on a project-basis. *Knowledge development* and *knowledge diffusion* were much less apparent here.

Another distinction is that civil society was an important actor in the TIS of the City of Cape Town, whereas they were not in eThekwini. In the City of Cape Town, they were mostly active in negative events surrounding *obstructing social acceptance* and *protests*. In eThekwini, reports of these types of events were almost absent. Nonetheless, interviewees did state that there were also social acceptance problems in eThekwini, but the coalition of driving actors was able to counteract resistance. Issues brought up by communities were taken into account, and the coalition spent a lot of resources on these issues.

4.3.2. Coalitions

Another big difference is the ability to form coalitions. eThekwini put much effort into this. They had a partnership with their local university for years through which they were able to *develop and diffuse knowledge*, which meant they were a stable environment for investors looking into decentralized sanitation solutions. Their partnership with BMGF had a considerable influence on the progress they were able to make. They could get the money to invest in pilots and form new partnerships through the network of BMGF with international private companies and knowledge institutes. Many interviewees noted that without the funding of BMGF, the positive developments in eThekwini could not have happened. Although some events were identified counteracting TIS development in eThekwini, no coalition could be identified driving these events. Some interviewees mentioned that the lower density of inhabitants in eThekwini could have made it more difficult for opponents to organize themselves and take collective action.

The City of Cape Town also formed a few partnerships, but not with the same consistency as in eThekwini. Partnerships were mostly formed on a project basis. Therefore, besides a short coalition of NGOs and the municipality around 2011 and 2012, no stable coalition driving positive TIS development could be distinguished. On the other hand, NGOs, opposing political parties, and civil society did form a longstanding relationship in counteracting development regarding decentralized sanitation solutions.

Having a stable coalition allows for other advantages. The same person led EWS for decades until he retired in 2015. One of their most important partners, the Pollution Research Group at UKZN, was also led by the same person over that time. Interviewees also noted that the political basis was relatively stable. All of this together meant that these leaders and their teams were able to take the time to create and execute the right strategy for their long-term vision. Furthermore, knowledge developed through the projects was institutionalized through longstanding employees.

In the City of Cape Town, a higher turn-over has been reported with new mayors and new utility leaders every few years. Every few years, trust had to

be rebuilt, vision had to be created repeatedly, and new strategies had to be implemented.

4.3.3. Institutional Work Strategies

In eThekwini, the institutional work that contributed to TIS development was aligned with the institutional work used to counteract TIS development. The coalition listened to safety issues raised by civil society and NGOs and used its human, intellectual, and financial resources to provide solutions for these issues. Furthermore, community liaison officers were deployed to effectively communicate policies and educate civil society about decentralized sanitation solutions. Summarized, in eThekwini, the creation of a coalition with a shared vision was the most important strategy to assure stability, and communication was the tool to provide this stability even in a context with counteracting political work.

In the City of Cape Town, little alignment could be distinguished from the most prominent institutional work strategies to drive TIS development. At first, the municipality mainly focused on *community participation* to create a support base for their solutions. After that, little positive institutional work strategies by the municipality could be distinguished. On the other hand, the opposing actors focused heavily on *political work* and *protests*, thereby counteracting TIS development.
Table 9 summarizes the main comparison points between the two municipalities.

Table 9. Comparison between the two municipalities

	eThekwini	**City of Cape Town**
Most important actors	Municipality, knowledge institutes, and NGOs	Municipality, NGOs, and civil society
Contributing coalition	EWS, UKZN & BMGF (+ private sector from 2017 onwards)	Absent except for 2011-2012 (municipality and SJC)
Counteracting coalition	Absent	ANC, SJC, Khayelitsha
Institutional work (positive)	Strategy: Creating a coalition with a shared vision to attract new partners	Community participation
Institutional work (negative)	Safety issues	Political work and protests

4.4. Summary of Results

In the theoretical section, it was substantiated that the performance on the system function *legitimation*, measured by the institutional work performed by driving and opposing actors, would influence other system functions and could

lead to further growth and development in case of successful legitimation or deterioration of the system in case of failure to create legitimacy. In the following paragraphs, the two cases are compared through this theoretical lens.

In eThekwini, a coalition of EWS, UKZN, and BMGF arose that pursued a lot of institutional work, especially in the beginning phase around 2011 and 2012. This coalition can be considered 'resourceful' since they have the human, intellectual, and financial resources available to pursue a vision and implement new solutions. Through developing a shared long-term vision around decentralized sanitation and political alignment, they were able to attract knowledge institutes, NGO's and private sector companies around the world to co-develop decentralized sanitation solutions. In the first few years, the focus was on *knowledge development* and *knowledge diffusion (F2, F3)*. Although *social acceptance* was initially low for the urine diversion toilets, through *educating* and *community participation*, the coalition of actors was able to improve the technology and adapt it to the users' needs. Although some NGOs and parts of civil society were opposed to their solutions, they did not gather in a coalition and mainly focused on demanding specific technological improvements. This provided *guidance of the search (F4)*. Also, by creating the knowledge sanitation hub at UKZN and providing test sites for new technologies in Durban, *market formation (F5)* and *entrepreneurial activities (F1)* were activated. Around 2019, some *political work* arose, which could impact the stability of the TIS. However, in 2020 a new big housing project has started, which brings together all the developed knowledge and technologies and should set the benchmarks for the future of decentralized sanitation. All in all, the success factors seem to be threefold: political alignment, a resourceful coalition, and institutional work adapted to civil society.

In the City of Cape Town, a completely different situation arose. In comparison to eThekwini, the political situation was not aligned as the nationally opposing political party DA led the province and municipality. Potential partners for the municipality noted that it was difficult to collaborate with the municipality since much bureaucracy was reported. The City of Cape Town mostly had to do it independently, while opposing political party ANC, NGO SJC, and civil society opposed the new technologies with *political work* and *protests*. Although the municipality tried to work with communities through *community participation*, it was nearly impossible due to the NGOs' counteracting institutional work in the form of *protests*, *political work*, *legal actions*, and counteracting *community participation*. The City of Cape Town was unable to provide a long-term vision in this challenging context. This influenced the overall TIS. Throughout the years, *legitimation* and *guidance of the search* were the most reported events. However, in eThekwini, *guidance of the search* led to renewed *knowledge development* and *market formation*. In the City of Cape Town, *guidance of the search* mostly resulted in new directions with new complaints from the opposing coalition. In ten years' time, no notable TIS development could be distinguished. All in all, political misalignment, lack of continuous partnerships, and a lack of community participation seem to be the barriers to positive TIS development.

5. Conclusions

The following research question guided this research:

How did actors in the decentralized sanitation TISs in eThekwini and the City of Cape Town try to legitimize decentralized sanitation services, and how have these actions impacted the systems' performances from 2010 to 2020?

An abductive approach was taken with an event analysis based on TIS and institutional work as a starting point to answer this research question. From 270 news articles and 8 policy reports, events were distilled and categorized into the various event types within the seven system functions and institutional work types. Per event, the involved actors were tracked to distinguish dominant actor types and networks. The events for the system function *legitimation* were further categorized into the various institutional work types earlier discussed. The overall developments of the TISs were described through trend patterns and interaction patterns. Furthermore, the driving and opposing actors, including their legitimation activities, were distinguished and analyzed. The storyline and outcomes were validated through 11 expert interviews distributed over the various actor types.

The overall research question was answered through four sub-questions. The answers to each sub-question are discussed next.

Which are the most important actors, networks, and institutions forming the TISs concerning the decentralized sanitation sectors in eThekwini and the City of Cape Town?

In eThekwini, the municipality, NGOs, and knowledge institutes were the main actors driving TIS development. The private sector became more involved throughout the years. Civil society was less prominent and mostly focused on institutional work to arrive at improvements in the provided technologies. EWS, UKZN, and BMGF formed a resourceful coalition and created a shared vision that attracted (international) partners, both knowledge institutes and private sector companies, to join the development of decentralized sanitation solutions. eThekwini mostly focused on urine diversion toilets for rural areas and communal ablution blocks for denser areas as solutions. The Urban Development Line determines the type of services that areas receive, based on their geographical location.

In the City of Cape Town, the municipality, NGOs, and civil society were the main actors, both driving and opposing TIS development. NGOs and civil society partnered to oppose TIS development. Private sector companies and knowledge institutes were far less involved than in eThekwini. The City of Cape Town provides sanitation solutions based on topological conditions, economic feasibility, available space, and land ownership. The preferred choice is

centralized sanitation, but when the conditions are not met, various types of (decentralized) solutions can be chosen from a catalog in collaboration with the residents.

How well are the system functions fulfilled for these decentralized sanitation TISs for both municipalities?

In eThekwini, a transition can be found from a new and developing TIS into a more mature TIS with all system functions coherently aligned. In the first few years, *knowledge development* (F2), *knowledge diffusion* (F3), and *legitimation* (F7) were mostly reported. The coalition built a shared long-term vision and communicated this vision through various channels while creating the knowledge needed to pursue this vision. From 2014 onwards, more *guidance of the search* (F4) was provided through *community participation* and new (international) partners. *Resources mobilization* (F6) was also activated with new funding from BMGF. From 2017 onwards, all system functions were activated when Durban became the test site for all technologies outputted in the Reinvent the Toilet Challenge, and private sector companies joined research projects.

All in all, it started with *legitimation* (F7), *knowledge development* (F2), and *knowledge diffusion* (F3). From 2014 onwards, *guidance of the search* (F4) and *resources mobilization* (F6) were activated. From 2017 onwards, *entrepreneurial activities* (F1) and *market formation* (F5) were also triggered, leading to a well-aligned coherent TIS.

In the City of Cape Town, the TIS did not develop positively throughout the years. Besides the first two years, in each year, more negative events than positive events were found. Especially *legitimation* (F7) drove negative TIS development. Throughout the years, the main system functions in play did not change much. *Knowledge diffusion* (F3) and positive *legitimation* (F7) mostly led to positive TIS development, while negative *legitimation* (F7) and a lack of *market formation* (F5) drove negative TIS development. *Entrepreneurial activities* (F1) and *knowledge development* (F2) were nearly absent. This is also reflected in the most important actors. Private sector companies and knowledge institutions had little involvement.

Which types of institutional work can be distinguished, and how did they affect the systems' performances?

In eThekwini, institutional work leading to positive TIS development mostly focused on *framing discourses*, *changing normative associations*, and *community participation*. Through *framing discourses*, positive interpretations of the provided solutions were spread by the driving coalition, allowing for *knowledge development (F2)* and *knowledge diffusion* (F3). Furthermore, through *changing normative associations* by communicating the business opportunities of decentralized sanitation, private sector companies were attracted to enter the industry, thereby activating *entrepreneurial activities* (F1) and *market formation* (F5). Lastly, *community participation* included communicating with citizens

about the issues they encountered and educating them on correctly using the solutions. Interviewees mentioned this institutional work by the coalition as the main reason for its success in developing decentralized sanitation, thus enhancing TIS performance. Negative institutional work focused on *political work*, *safety issues,* and *obstructing social acceptance*. *Political work* centered around accusations of corruption to decrease trust in the municipal government. *Safety issues* were mostly brought up by NGOs but effectively dealt with by the driving coalition by improving the solutions' design. Lastly, *obstructing social acceptance* was driven by civil society and dealt with by assigning officers to educate people on these solutions and communicate with people about these solutions. Overall, negative institutional work did not influence the TIS performance but influenced the development trajectories of the decentralized sanitation services through *guidance of the search* (F4), which resulted in improved designs of decentralized solutions.

Whereas in eThekwini, institutional work led to mostly positive TIS development, in the City of Cape Town, it blocked TIS development altogether. In absolute numbers, there were four times more events indicating institutional work leading to negative TIS development as institutional work leading to positive TIS development in the City of Cape Town. Just as in eThekwini, *community participation*, *framing discourses*, and *changing normative associations* were mostly reported as positive institutional work. However, the most important actors performing this institutional work were not collaborating. Whereas NGOs and civil society focused on *community participation*, the municipality was driving *framing discourses* and *changing normative associations*. This created a misalignment in institutional work. From the data, it was found that this institutional work mostly influenced *knowledge diffusion* (F3) and *guidance of the search* (F4), but it failed to activate other TIS functions. Negative institutional work mostly focused on *protests*, *political work*, *safety issues*, and *obstructing social acceptance*. Whereas the positive institutional work was misaligned, the negative institutional work was performed by a coalition of opposing political party ANC, NGOs, and civil society. ANC performed *political work*, NGOs brought up *safety issues*, and civil society heavily communicated the lack of *social acceptance* through various media channels. Collectively, this led to many *protests* blocking TIS development. These actions influenced *guidance of the search* (F4) negatively and blocked *market formation* (F5).

<u>What inducement and blocking mechanisms support or hinder the performance of the decentralized sanitation TISs?</u>

By comparing the two approaches combined with the TIS development, some inducement and blocking mechanisms could be distinguished. The success of eThekwini in terms of TIS development can largely be attributed to the municipality's ability to form longstanding partnerships with knowledge institutes and NGOs. Stability in terms of trust with politicians and citizens provided the freedom to operate, build a long-term vision, and attract partners. These partners delivered the essential resources: intellectual resources by

UKZN and financial resources by BMGF. These longstanding partnerships allowed for institutionalizing knowledge.

To conclude the case of eThekwini, longstanding partnerships with resourceful partners, trust with citizens created through institutional work, and the successful institutionalizing of knowledge thanks to overall stability were distinguished as inducement mechanisms leading to an overall more coherently developed TIS. These mechanisms were self-reinforcing in the sense that positive progress provides a strong foundation for institutional work, which then leads to new partners, renewed trust, and the continuation of existing collaborations.

The City of Cape Town was much less able to guide the search for decentralized sanitation solutions. Political misalignment caused significant legitimation issues, especially in terms of trust, both within the municipality as with the citizens. This lack of trust led to protests and a prolonged low social acceptance of the decentralized sanitation solutions. New solutions were rejected in advance due to a lack of legitimacy. This rejection is then covered extensively in media outlets, causing the municipality to become more risk-averse and more bureaucratic. This makes it difficult to form partnerships and attract resources, leading to an overall deterioration in TIS performance.

To conclude the case of the City of Cape Town, a lack of trust and partnerships resulting from political misalignment, intense protests, and increased bureaucracy were distinguished as blocking mechanisms for the performance of the TIS. These mechanisms were also self-reinforcing, making it challenging to make any progress. The City of Cape Town is therefore trapped in a negative vicious cycle.

6. Discussion

In this section, the theoretical implications of this research are discussed. After that, implications for management and policies are debated. Lastly, the limitations of this research are considered.

6.1. Theoretical Implications

In this first section, several theoretical implications are discussed. Firstly, newly identified types of institutional work are examined. After that, the combination of the TIS and institutional work approach is discussed.

6.1.1. Newly Identified Types of Institutional Work

Various institutional work types have already been identified and summarized by Binz et al. (2016) and Fuenfschilling and Truffer (2016). In this thesis, eight newly identified types have been added. These newly identified types resulted from bottom-up coding and were added to the list of types as they led to specific TIS development in the context of decentralized sanitation solutions. These types are discussed next with its implications on TIS development.

The most important newly identified type of institutional work was *creating and obstructing social acceptance*, referring to encouraging citizens to use or not use the new solutions, regardless of the type of solution offered. Civil society and NGOs used this type of institutional work to guide actors towards very different solutions. It is a strong type of institutional work as it is meant to reject the innovation altogether, regardless of its advantages. This blocks the overall development of the innovation.

Furthermore, existing TIS studies have not yet explored the role of *protests* in driving TIS functions. However, *protests* is a strong type of institutional work, as it generates a lot of media attention and could therefore critically force the government to respond and provide explanations and perspective on improvements. In this way, it could be a key strategic mechanism to TIS development, especially in terms of driving *guidance of the search* (F4), but it could also distract actors from their long-term vision as they need to respond to short-term issues. *Legal actions* have the same result and can be considered a way to protest by going to court. However, actors are forced to abide by the court's rulings, and thus *legal actions* could drive *guidance of the search* (F4) in an even more pressing way than *protests*.

Framing discourses relates to the framing by actors of certain issues or solutions (Druckman, 2001). Actors present an issue or solution in such a way to emphasis certain aspects of it. Social science has shown that the public opinion depends on how an issue or solution is framed. In the case of decentralized sanitation, actors use frames to communicate the need for a particular innovation or the

lack of this need in terms that they expect will go down well with society. *Framing discourses* could be crucial to the acceptance of an innovation as it allows leading actors to focus on specific advantages in their communication while moving some disadvantages or issues to the background. For instance, driving actors focused on the sustainable aspect of the decentralized solutions, while opposing actors focused on the inequality aspect of these solutions. One specific frame that was appointed its own category due to the high number of references was *safety*. This relates to the effects of the innovation on health and safety. This was especially relevant in the case of decentralized sanitation solutions. If a particular solution did not fit with the established practices of the user, the user would have to go outside for defecation, leading to potential risks of violence and health issues.

Another important aspect in relation to the local context is *community participation*. If done well, communities are included in decisions affecting their community and become part of the solution. Citizens in informal settlements often feel like second-class citizens and not supported by the government. Through *community participation*, civil society becomes an important actor in *guidance of the search* (F4).

Lastly, two types of institutional work were identified that specifically aim to lower the credibility of the leading actor(s). One of these types was labeled as *disbelief in governmental capabilities* and refers to publicly doubting that the government has the capabilities to pursue their strategy. The other type was *doubting data validity* referring to questioning data that should underpin the innovation's effectiveness. If one or both of these types are used consistently by various actors, it undermines the government's ability to attract resources and act.

Future research could focus on validating these newly identified types in different contexts and to test if these types are generalizable to other cases.

6.1.2. Combination of TIS and Institutional Work

TIS provides a meso-level perspective on transitions and therefore focuses less on individual actors, their strategies, positions, and activities. Markard et al. (2015) suggested that a micro-level analysis, in addition to the regular TIS analysis, allows for more in-depth explanations of the dynamics within TIS. Therefore, in this thesis, emphasis was placed on driving and opposing actors and their activities. Following the suggestion by Binz et al. (2016) for further research, focus was put on which actors drove what processes regarding legitimation. Each event was coded with the actors involved, allowing for analyses of individual actors and their relation to TIS development.

Figure 10 illustrates this bridge between a micro- and meso-level perspective and shows how institutional work could influence the performance of system functions. The figure shows a simplified representation of the results such an

analysis could lead to. The number of actors, institutional work strategies, and arrows are symbolic.

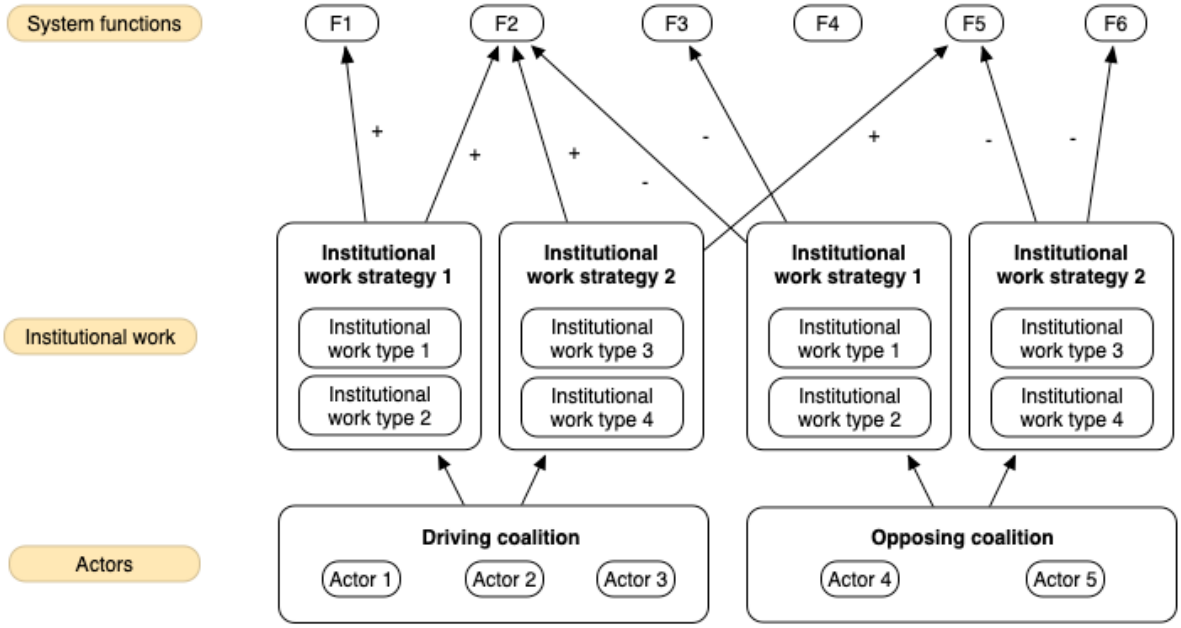

Figure 10. Bridge micro- and meso-level perspective in TIS

To simplify reality, actors are divided into a driving and opposing coalition, each with its own institutional work strategies consisting of various institutional work types. Each coalition has several strategies directed at different parts of the system's performance. When the driving or opposing actors are less organized, it could also be individual actors or actor types pursuing their individual strategies to try to influence system functions.

Looking at Figure 10, one could wonder if it is possible to generalize that certain strategies lead to certain positive or negative development in specific system functions. Previous categorizations of institutional work types focused on a distinction between types that aim to create institutions, align institutions, or destroy institutions. However, combining a TIS and institutional work approach, it could help to categorize the types based on the influence on system functions. The inducement and blocking mechanisms found in this research could provide a first idea of how institutional work types come together to induce or block TIS development.

For instance, the institutional work strategy consisting of *protests, legal action,* and *safety,* which was typically used to negatively influence *guidance of the search* (F4) in the case of the City of Cape Town. Another example was the institutional work strategy to form coalitions consisting of *constructing normative networks, framing discourses,* and *changing normative associations* which led to the *mobilization of resources* (F6) in the case of eThekwini.

One could imagine that such categorization could accelerate TIS development if it is known which system functions are currently underperforming. More research on this subject in more diverging contexts should prove if such a categorization is feasible and generalizable.

Lastly, institutional work could also bridge the gap between identified system weaknesses and the policy tools to overcome these weaknesses. Policy frameworks based on TIS, such as the framework by Wieczorek and Hekkert (2012), help policymakers to identify weaknesses in the system based on system function performance and provides a toolbox of policy tools to overcome these weaknesses. However, they do not focus on the processes needed to implement these policy tools successfully. For instance, when few collaborations between actors occur, cooperative research programs are proposed to stimulate interactions. However, these programs can only start if actors wish to get involved and provide their resources for such programs. In this example, *framing discourses* or *constructing normative networks* could be needed to get actors involved. Future research could focus on validating institutional work strategies as an additional tool for implementing policy measures.

6.2. Managerial and Policy Implications

Based on this research's findings, policymakers and managers could use some of the institutional work strategies described in this thesis. Some potential scenarios and potential practices are discussed next. Policymakers dealing with transitions could benefit from mapping the actors opposing the matter, their institutional work strategies, and influence on the system's performance. Based on this mapping, policymakers and managers could better strategize their institutional work when dealing with low social acceptance. The case of eThekwini provides useful leads for this. The main strategy was communicating with citizens, listening to their complaints, and adapting the technology based on these complaints. If technological solutions for their complaints are not possible, framing the issue in such a way that the solution is also in their interests can effectively resolve social acceptance issues. In eThekwini, complaints about pedestals of urine diversion toilets that were difficult to use could be resolved by improving the pedestals in collaboration with the user. However, the discussion about inequality and how these decentralized solutions are forced upon the poor people in rural areas could not be technically solved. The municipality paid citizens for urine collection to show the value of nutrients in urine. Besides that, citizens were made aware that with water supply issues, these urine diversion toilets are needed to meet the water demand. In this way, the municipality steered the discussion to the ecological and economic aspects of decentralized sanitation.

Furthermore, the findings suggest that continuous collaborations with partners with resources that complement already owned resources could speed up transitions tremendously. There is not a fixed recipe to arrive at useful partners. However, based on this thesis's findings, especially looking at the so-called

resourceful coalition in eThekwini, it seems possible to increase the chances of finding useful partners by sharing a vision through media, communicating possible opportunities, and generally, to be visible. That means visiting conferences, doing press releases, visiting similar organizations in other countries, among other things. For eThekwini, this turned out very well with the global NGO BMGF as new partner, which provided the necessary financial resources to develop decentralized sanitation solutions further.

Lastly, this research's findings indicate that it is nearly impossible to arrive at positive TIS development in case of political misalignment. However, for a few years, the City of Cape Town was able to make some progress. This progress was enabled by a shared vision, clear communication, and trust-building through various discussion meetings. Even in a heavily politicized context, this enabled progress. Following this strategy, it might be easier to prevent protests or respond to protests and other negative institutional work in a more constructive manner. On the other hand, the lack of progress after the first few years was caused by heavy protests and political work, resulting from a lack of communication with opposing parties resulting in the inability to arrive at mutual understanding. Plotting the case of eThekwini on the City of Cape Town, it is expected that the City of Cape Town could benefit from creating a shared vision on decentralized sanitation, collectively with their opponents and sharing this vision through media and conferences to attract partners for continuous development of their vision.

6.3. Limitations

Although this research has been conducted following the research quality criteria in the methodology section, some limitations apply to this research. In this section, these limitations are discussed to embed this thesis into the existing literature appropriately.

First of all, this research applies to two case studies in a specific context. Specific findings cannot readily be generalized to other situations due to the contextual uniqueness of South Africa and its water and sanitation policies. However, the politicization of service delivery is widespread in the Global South. Furthermore, the case of eThekwini can be considered a less politicized case and considered to be more applicable in case of political alignment. Nonetheless, other researchers should critically assess if findings are transferable to different contexts. This thesis allows them to do so since the context of South Africa and the municipalities and their influence on TIS development have been described in-depth. Future research could focus on the applicability of institutional work strategies and their influence on TIS development in different contexts to further enhance generalizability.

Secondly, a lot of the data of this research were retrieved from news articles. News articles do not always provide a balanced view of reality, as news outlets are expected to bring 'news', thus unusual situations rather than general

practices. Therefore, triangulation was performed through expert interviews with experts from various actor types. Unfortunately, it could not be managed to interview representatives of civil society. Nonetheless, their influence on the TIS was triangulated with the other experts, and especially the NGO representative provided validation on the role of civil society. As *social acceptance* played a significant role in this specific context, future research could focus on civil society's role, including fieldwork, to further deepen the dynamics leading to *social acceptance*.

References

Aldrich, H. E., & Fiol, C. M. (1994). Fools Rush in? The Institutional Context of Industry Creation. *Academy of Management*, *19*(4), 645–670. https://doi.org/10.2307/258740

Bergek, A., Hekkert, M., & Jacobsson, S. (2008). Functions in Innovation Systems: a framework for analysing energy system dynamics and identifying goals for system building activities by entrepreneurs and policy makers. In T. Foxon, J. Köhler, & C. Oughton (Eds.), *Innovation for a Low Carbon Economy*. Cheltenham, United Kingdom: Edward Elgar. https://doi.org/10.1016/j.respol.2007.12.003

Binz, C., Harris-Lovett, S., Kiparsky, M., Sedlak, D. L., & Truffer, B. (2016). The thorny road to technology legitimation - Institutional work for potable water reuse in California. *Technological Forecasting and Social Change*, *103*, 249–263. https://doi.org/10.1016/j.techfore.2015.10.005

Bond, P. (2020). Tokenistic water and neoliberal sanitation in post-apartheid Durban. *Journal of Contemporary African Studies*, *37*(4), 275–293. https://doi.org/10.1080/02589001.2019.1710115

Bryman, A. (2012). *Social Research Methods* (4th ed.). Oxford, United Kingdom: Oxford University Press.

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics*, *1*(2), 93–118. https://doi.org/10.1007/BF01224915

City of Cape Town. (2020). Meet the City. Retrieved August 15, 2020, from http://www.capetown.gov.za/Family and home/Meet-the-city

Druckman, J. N. (2001). The implications of framing effects for citizen competence. *Political Behavior*, *23*(3), 225–256. https://doi.org/10.1023/A:1015006907312

DWS. (2019). *National Water and Sanitation Master Plan—Volume 1: Call to Action*. Retrieved from https://cisp.cachefly.net/assets/articles/attachments/80785_nwsmp(master_plan)_call_to_action_v10.1.pdf

Edquist, C. (1997). *Systems of innovation: Technologies, institutions, and organizations*. London, United Kingdom: Pinter.

eThekwini Municipality. (2008). Levels of Service and Dwelling Count - Sanitation. Retrieved March 26, 2020, from http://www.durban.gov.za/PublishingImages/City Services/Engineering/2_Sanitation_may2008_dwelling_count11.jpg

eThekwini Municipality. (2020). About eThekwini Municipality. Retrieved August 15, 2020, from http://www.durban.gov.za/Discover_Durban/Pages/AboutEM.aspx

Freeman, J., Carroll, G. R., & Hannan, M. T. (1983). The Liability of Newness: Age Dependence in Organizational Death Rates. *American Sociological Review*, *48*(5), 692–710. https://doi.org/10.2307/2094928

Fuenfschilling, L., & Truffer, B. (2016). The interplay of institutions, actors and technologies in socio-technical systems - An analysis of transformations in

the Australian urban water sector. *Technological Forecasting and Social Change*, *103*, 298–312. https://doi.org/10.1016/j.techfore.2015.11.023

Galvin, M. (2016). Leaving boxes behind: Civil society and water and sanitation struggles in Durban, South Africa. *Transformation: Critical Perspectives on Southern Africa*, *92*(1), 111–134. https://doi.org/10.1353/trn.2016.0029

Google. (n.d.-a). [City of Cape Town]. Retrieved April 19, 2020, from https://goo.gl/maps/v6AXaYP2TcKCvaAa9

Google. (n.d.-b). [eThekwini Municipality]. Retrieved April 19, 2020, from https://goo.gl/maps/1xfKBV2qBZcrgBFLA

Google. (n.d.-c). [South Africa]. Retrieved April 19, 2020, from https://goo.gl/maps/KFYbf8DkA2q6sMAJ7

Guba, E. G., & Lincoln, Y. S. (1994). Competing Paradigms in Qualitative Research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (eds). Thousand Oaks, Canada: Sage.

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change*, *74*(4), 413–432. https://doi.org/10.1016/j.techfore.2006.03.002

Markard, J., Hekkert, M., & Jacobsson, S. (2015). The technological innovation systems framework: Response to six criticisms. *Environmental Innovation and Societal Transitions*, *16*, 76–86. https://doi.org/10.1016/j.eist.2015.07.006

Markard, J., Wirth, S., & Truffer, B. (2016). Institutional dynamics and technology legitimacy - A framework and a case study on biogas technology. *Research Policy*, *45*(1), 330–344. https://doi.org/10.1016/j.respol.2015.10.009

Martel, P., & Sutherland, C. (2019). Governing River Rehabilitation for Climate Adaptation and Water Security in Durban, South Africa. In P. B. Cobbinah & M. Addaney (Eds.), *The Geography of Climate Change Adaptation in Urban Africa*. New York, United States: Springer Publishing.

McFarlane, C., & Silver, J. (2016). The Poolitical City: "Seeing Sanitation" and Making the Urban Political in Cape Town. *Antipode*, *49*(1), 125–148. https://doi.org/10.1111/anti.12264

Mels, A., Castellano, D., Braadbaart, O., Veenstra, S., Dijkstra, I., Meulman, B., … Wilsenach, J. A. (2009). Sanitation services for the informal settlements of Cape Town, South Africa. *Desalination*, *248*(3), 330–337. https://doi.org/10.1016/j.desal.2008.05.072

Pan, S. (2016). *"What is to be sustained for whom?": Equity as a key to sustainable sanitation in South African informal settlements*. Retrieved from http://hdl.handle.net/11427/22872

Peirce, C. (1934). Pragmatism and Pragmaticism. In C. Hartshorne & P. Weiss (Eds.), *Collected Papers of Charles Sanders Peirce*. Cambridge, United Kingdom: Harvard University Press.

Reddy, P. S. (2016). The politics of service delivery in South Africa: The local government sphere in context. *The Journal for Transdisciplinary Research in Southern Africa*, *12*(1), 1–8. https://doi.org/10.4102/td.v12i1.337

Redfield, P., & Robins, S. (2016). An index of waste: humanitarian design, "dignified living" and the politics of infrastructure in Cape Town.

Anthropology Southern Africa, *39*(2), 145–162. https://doi.org/10.1080/23323256.2016.1172942

Robins, S. (2014). Poo wars as matter out of place: "Toilets for Africa" in Cape Town. *Anthropology Today*, *30*(1), 1–3. https://doi.org/10.1111/1467-8322.12081

Scoones, I., & Stirling, A. (2020). *The Politics of Uncertainty: Challenges of Transformation* (1st ed.). New York, United States: Routledge.

Scoones, I., Stirling, A., Abrol, D., Atela, J., Charli-Joseph, L., Eakin, H., … Yang, L. (2020). Transformations to sustainability: combining structural, systemic and enabling approaches. *Current Opinion in Environmental Sustainability*, *42*, 65–75. https://doi.org/10.1016/j.cosust.2019.12.004

Sim, V., Sutherland, C., & Scott, D. (2016). Pushing the boundaries – urban edge challenges in eThekwini Municipality. *South African Geographical Journal*, *98*(1), 37–60. https://doi.org/10.1080/03736245.2015.1052840

Stats SA. (2012). Statistics by Place. Retrieved March 26, 2020, from http://www.statssa.gov.za/?page_id=964

Stats SA. (2019). General Household Survey, Selected development indicators, Metros, 2018. Retrieved March 26, 2020, from http://www.statssa.gov.za/publications/P03183/P031832018.pdf

Sutherland, C., Hordijk, M., Lewis, B., Meyer, C., & Buthelezi, S. (2014). Water and sanitation provision in eThekwini Municipality: a spatially differentiated approach. *Environment and Urbanization*, *26*(2), 469–488. https://doi.org/10.1177/0956247814544871

Sutherland, C., Scott, D., & Hordijk, M. (2015). Urban Water Governance for More Inclusive Development: A Reflection on the 'Waterscapes' of Durban, South Africa. *The European Journal of Development Research*, *27*(4), 488–504. https://doi.org/10.1057/ejdr.2015.49

Suurs, R. A. A., & Hekkert, M. P. (2009). Cumulative causation in the formation of a technological innovation system: The case of biofuels in the Netherlands. *Technological Forecasting and Social Change*, *76*(8), 1003–1020. https://doi.org/10.1016/j.techfore.2009.03.002

Tilley, E., Ulrich, L., Lüthi, C., Reymond, P., & Zurbrügg, C. (2014). *Compendium of Sanitation Systems and Technologies* (2nd ed.). Dübendorf, Switzerland: Eawag.

Timmermans, S., & Tavory, I. (2012). Theory construction in qualitative research: From grounded theory to abductive analysis. *Sociological Theory*, *30*(3), 167–186. https://doi.org/10.1177/0735275112457914

United Nations. (2020a). Ensure availability and sustainable management of water and sanitation for all. Retrieved February 19, 2020, from https://sustainabledevelopment.un.org/sdg6

United Nations. (2020b). Sustainable Development Goals. Retrieved February 18, 2020, from https://sustainabledevelopment.un.org/sdgs

Vadra, R. (2017). Knowledge Economy in BRICS: a Case of South Africa. *Journal of the Knowledge Economy*, *8*(4), 1229–1240. https://doi.org/10.1007/s13132-017-0512-y

van de Ven, A. H. (2007). *Engaged Scholarship: A Guide for Organizational and Social Research*. New York, United States: Oxford University Press.

van Welie, M. J., Cherunya, P. C., Truffer, B., & Murphy, J. T. (2018). Analysing transition pathways in developing cities: The case of Nairobi's splintered sanitation regime. *Technological Forecasting and Social Change*, *137*, 259–271. https://doi.org/10.1016/j.techfore.2018.07.059

van Welie, M. J., Truffer, B., & Yap, X. S. (2019). Towards sustainable urban basic services in low-income countries: A Technological Innovation System analysis of sanitation value chains in Nairobi. *Environmental Innovation and Societal Transitions*, *33*, 196–214. https://doi.org/10.1016/j.eist.2019.06.002

Wieczorek, A. J., & Hekkert, M. P. (2012). Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy*, *39*(1), 74–87. https://doi.org/10.1093/scipol/scr008

Acknowledgements

Last summer, I was supposed to do fieldwork in South Africa. Of course, due to the current Covid-19 situation, that was not possible. Although the process went entirely different from what we had planned, I still had a great experience writing this thesis.

I want to thank my supervisor, dr. Xiao Shan Yap for her help during this process. I always left our (virtual) meetings with a great spark of inspiration. I would also like to thank prof. dr. Bernhard Truffer, who took the time to provide some guidance at crucial pivot points during the process.

I also want to thank the interviewees, who were willing to share their insights with me. Even though I could not visit the municipalities myself, I could still get a good grasp of the context through our conversations.

Lastly, I would like to thank some of my fellow students, to whom I will refer as *QIA*. I hope I was able to provide them with as much support as I received from them.

Appendix A List of News Articles (eThekwini)

	Headline	Publication	Date
E1	Blue Flag plan for all beaches;Sutcliffe to 'engage' officials	Daily News (South Africa), NEWS; Pg. 2, 651 words	10-02-2011
E2	Award-Winning Sanitation Team Keen to Link to Fellow African Researchers [interview]	AllAfrica.com, 283 words	12-07-2011
E3	Shocking state of schools in KZN	The Mercury (South Africa), NEWS; Pg. 4, 902 words	08-08-2011
E4	Change a bulb, plant a treeâ€¦ not enough;The government needs to come clean and do justice by acting against perpetrators and reducing pollution	The Mercury (South Africa); Pg. 9, 1210 words	25-10-2011
E5	People living in squalor - after R25m hostel upgrade	The Herald (South Africa), POLITICS, 440 words	17-01-2012
E6	CITY LIVING - RISING COSTS. Ratepayers wrung out	Financial Mail (South Africa), ECONOMY, BUSINESS & FINANCE, 611 words	06-04-2012
E7	Durban aflush after winning hosting rights for World Toilet Summit	The Mercury (South Africa), NEWS; Pg. 4, 194 words	07-05-2012
E8	Africa;Bill Gates on Inventing a Toilet for the 21st Century	Africa News, 813 words	14-08-2012
E9	Partnership to boost health in SA	The Mercury (South Africa), NETWORK; Pg. 3, 661 words	07-11-2012
E10	Dreams of Better Sanitation Go Down the Toilet	AllAfrica.com, 787 words	19-11-2012
E11	MPs raise stink over sanitation summit	Sowetan (South Africa), POLITICS, 363 words	29-11-2012
E12	South Africa;It Is Shocking That Ethalaneni Residents	Africa News, 315 words	04-12-2012
E13	Government urged to pay attention to sanitation crisis	Business Day (South Africa), HEALTH, 469 words	05-12-2012
E14	I wish JZ was an efficient grafter like the city street sweeper	Sunday Tribune (South Africa); Pg. 19, 756 words	10-03-2013
E15	Residents have to walk 500m	Sowetan (South Africa), DEFAULT, 356 words	06-05-2013
E16	No Headline In Original	Cape Times (South Africa), NEWS, 1303 words	08-05-2013
E17	Paying for unsightly monuments to poo	Daily News (South Africa); Pg. 8, 301 words	05-08-2013
E18	Poo fighters deserve the full might of the law	Cape Argus (South Africa); Pg. 16, 550 words	06-09-2013
E19	Let us lift the national toilet lid and examine the contents	Sowetan (South Africa), OPINION & EDITORIAL, 666 words	26-11-2013
E20	No time for the masses when it comes to bucks	The Mercury (South Africa); Pg. 7, 623 words	28-01-2014
E21	Toilet pledge turns to poo 'These thugs must leave'	Daily News (South Africa), 866 words	19-03-2014
E22	Domestic services tariffs go up	Daily News (South Africa), 588 words	20-03-2014
E23	-UNIVERSITY OF BRISTOL -Urine-power experts reinvent the toilet	ENP Newswire, 668 words	20-03-2014
E24	Mayor slams ANC 'proxies'	Cape Argus (South Africa), NEWS; Pg. 2, 585 words	24-07-2014
E25	No suitable toilets for thousands	Sunday Tribune (South Africa), NEWS; Pg. 20, 161 words	30-11-2014

E26	Residents blame Durban oil refineries for health problems;Bill Gates funds ground-breaking sanitation research in Durban, but in the communities living under pollution from oil refineries just a short drive away - run by companies in which Gates is invested - asthma and cancer rates are high	The Guardian, ENVIRONMENT, 2110 words	26-05-2015
E27	Domestos' Brighter Future Campaign gives 24 schools new toilets	Bizcommunity.com (South Africa: Retail), CORPORATE SOCIAL INVESTMENT, 719 words	28-07-2015
E28	Filthy school latrines 'routine'	The Times (South Africa), EDUCATION, 372 words	06-08-2015
E29	South Africa;Debate on the Adjustments Estimate Bill	Africa News, 1424 words	27-11-2015
E30	Report: SA cities doing well, but challenges remain	South African Official News, 973 words	23-06-2016
E31	Electoral Commission On Local Government Elections [press release]	South African Government, 1045 words	21-07-2016
E32	Second-lowest life expectancy	The Mercury (South Africa), NEWS; Pg. 1, 564 words	22-07-2016
E33	Delivery targets set for new councillors	Daily News (South Africa), NEWS; Pg. 2, 550 words	15-08-2016
E34	Many Indians build bridges, selflessly	Post (South Africa), NEWS; Pg. 19, 1259 words	21-09-2016
E35	CCTs for Pees: Cash Transfers Halloween Edition	Premium Official News, 974 words	31-10-2016
E36	The cruelty of climate change, Africa's poor suffer its effects	The Citizen (Tanzania), 2466 words	13-11-2016
E37	School receives cleaning products for a year	Sunday Tribune (South Africa), NEWS; Pg. 8, 215 words	20-11-2016
E38	Smooth start â€¨to school year	The Mercury (South Africa), NEWS; Pg. 4, 519 words	12-01-2017
E39	ANSI to Organize ISO International Workshop on Community-Scale Resource-Oriented Sanitation Treatment Systems	Targeted News Service, 447 words	03-04-2017
E40	MEC Mthandeni Dlungwana - Kwazulu-Natal Education Budget Vote 2017-18 [press release]	Government of South Africa, 10864 words	04-05-2017
E41	Gates mucks in with Durban latrines	The Mercury (South Africa), NEWS; Pg. 5, 456 words	22-05-2017
E42	Activists slam city neglect Activists slam city neglect	The Mercury (South Africa), NEWS, 570 words	30-05-2017
E43	Off-grid' Toilet to Be Tested in Durban, South Africa	Targeted News Service, 496 words	31-05-2017
E44	Uplifting Durban with a Healthy City initiative	Sunday Tribune (South Africa), NEWS; Pg. 12, 342 words	13-08-2017
E45	Duke, RTI International Partner on Improved Global Sanitation	US Official News, 304 words	28-08-2017
E46	The new alchemy of human waste	Cape Times (South Africa); Pg. 9, 1123 words	15-11-2017
E47	From the laboratory to the lavatory - developing fake poo could save thousands of lives	European Union News, 1086 words	23-11-2017
E48	School cleans up award	Sunday Tribune (South Africa), TRIBUNE HERALD; Pg. 1, 372 words	03-12-2017
E49	Struggles of Smartie Town families	Post (South Africa), NEWS; Pg. 2, 779 words	27-12-2017
E50	Corruption at the root of all SA's ills	Daily News (South Africa); Pg. 6, 240 words	05-03-2018

E51	Port Louis ranked best city in Africa for expats, according to Mercer's 20th Quality of Living Survey;Durban retains its top position as the best city in South Africa	Mercer LLC, 1191 words	23-03-2018
E52	Raw sewage is spilling into our front entrance'	Sunday Tribune (South Africa), NEWS; Pg. 12, 312 words	08-04-2018
E53	Mariannridge Secondary School reopens... but still no toilets	Daily News (South Africa), 381 words	25-04-2018
E54	Giant steps to assist Durban communities	The Mercury (South Africa), NEWS; Pg. 6, 1185 words	18-05-2018
E55	Durban's huge sewage headache	The Mercury (South Africa), NEWS; Pg. 3, 483 words	27-06-2018
E56	HUMAN WASTE CONVERTER INVENTED AT UNIVERSITY OF SOUTH FLORIDA RECOGNIZED AS READY FOR COMMERCIAL USE	US Fed News, 549 words	07-11-2018
E57	Bill Gates's bet to improve the hygiene crisis in the world	CE Noticias Financieras English, 435 words	08-11-2018
E58	Why Did Bill Gates Give A Talk With A Jar Of Human Poop By His Side?	Goats & Soda, 1114 words	09-11-2018
E59	Not to be pooh-poohed;New off-grid toilet technology way forward - UKZN pollution research head	The Independent on Saturday (South Africa); Pg. 6, 535 words	17-11-2018
E60	The toilet that converts poop into cooking fuel	Daily News (South Africa), 715 words	23-11-2018
E61	Waste not, want not as radical sewerless toilet is tested	Sunday Times (South Africa), SCIENCE & TECHNOLOGY, 477 words	16-12-2018
E62	Push to upgrade informal settlements;Summit adopts threefold approach - 'greenfields' projects, interim services and high-rise experimentation	Sunday Tribune (South Africa); Pg. 8, 825 words	17-02-2019
E63	Can white faecal pellets take over as the future fertiliser in global south?	Down To Earth, 548 words	01-04-2019
E64	Department of Women on Menstrual Hygiene Day	Premium Official News, 1111 words	28-05-2019
E65	Anger over sanitation strike report not tabled at eThekwini Exco	Daily News (South Africa), 574 words	21-06-2019
E66	Damning report paints bleak picture on state of eThekwini Municipality	Daily News (South Africa), 541 words	12-07-2019
E67	Broken toilets forces Sydenham school to close for two days	Daily News (South Africa), 254 words	21-08-2019
E68	Start-up gives job seekers a leg up	Sowetan (South Africa), ECONOMY, BUSINESS & FINANCE; Pg. 10, 411 words	11-10-2019
E69	Unbearable stench is tormenting residents	Post (South Africa), NEWS; Pg. 4, 635 words	19-02-2020
E70	Covid-19: City to provide hand sanitiser, liquid soap at informal settlements	Daily News (South Africa), 481 words	18-03-2020
E71	Coronavirus: SA 'Planning' to Relocate Crowded Townships	TechFinancials.co.za, 938 words	06-04-2020
E72	Serco supplies 'Sani-Booth' to Counter COVID-19 in the Workplace	AutoForum.co.za, 604 words	08-05-2020

Appendix B List of News Articles (City of Cape Town)

	Headline	Publication	Date
C1	Protesters line up to raise a stink about need for safe township loos	Cape Times (South Africa), NEWS; Pg. 3, 299 words	15-04-2011
C2	One toilet for 15 families	Sowetan (South Africa), SOCIAL ISSUES, 289 words	18-04-2011
C3	NOT HOLY BUSINESS	Sowetan (South Africa), POLITICS, 434 words	28-04-2011
C4	March for decent sanitation	The Star (South Africa), NEWS; Pg. 3, 210 words	28-04-2011
C5	City of Cape Town loses open-toilet battle	Mail & Guardian, 692 words	29-04-2011
C6	Tell us if loos are open-air, ANC says	The Star (South Africa), NEWS; Pg. 6, 158 words	12-05-2011
C7	High risk of diarrhoea in areas with poor sanitation	Cape Times (South Africa), NEWS; Pg. 5, 334 words	30-06-2011
C8	De Lille enlists SJC aid on backlogs	Cape Times (South Africa), NEWS; Pg. 4, 209 words	08-07-2011
C9	Longing to kick bucket system;More than 80 000 households contend with rudimentary sanitation	Cape Argus (South Africa), NEWS; Pg. 4, 581 words	11-08-2011
C10	Call for better sanitation	Sowetan (South Africa), HUMAN INTEREST, 383 words	16-09-2011
C11	ANC urges measures to address sanitation 'crisis'	Cape Argus (South Africa), NEWS; Pg. 4, 496 words	16-09-2011
C12	Coalition welcomes R138m project	Cape Times (South Africa), NEWS; Pg. 4, 305 words	04-10-2011
C13	De Lille to launch job project	Sowetan (South Africa), HUMAN INTEREST, 359 words	05-10-2011
C14	Clean-up drive for CT's shack dwellers	Sowetan (South Africa), SOCIAL ISSUES, 383 words	21-10-2011
C15	Bedford's bucket toilet backlog appalling, says official	The Herald (South Africa), SOCIAL ISSUES, 312 words	04-11-2011
C16	Residents tell Winnie of city's sanitation problems	Cape Times (South Africa), NEWS; Pg. 5, 371 words	06-12-2011
C17	Winnie aims to flush away toilet woes	Cape Argus (South Africa), NEWS; Pg. 4, 366 words	06-12-2011
C18	Team's toilets tour finds city services are looking up	Cape Times (South Africa), NEWS; Pg. 7, 327 words	07-12-2011
C19	Mayor is praised for 'creating empathy'	Cape Times (South Africa), NEWS; Pg. 7, 559 words	14-12-2011
C20	Design isn't just about shiny objects	Cape Times (South Africa); Pg. 9, 1156 words	31-01-2012
C21	Investment;Turning Maggots Into Cash	Africa News, 1400 words	09-03-2012
C22	Celebration over clean Cape Town toilets plan	Sowetan (South Africa), HUMAN INTEREST, 462 words	17-05-2012
C23	NGO notches up a little victory in battle for sanitation	Cape Times (South Africa), NEWS; Pg. 4, 354 words	17-05-2012
C24	People in low-cost housing are not being taken care of by the authorities	Cape Times (South Africa); Pg. 11, 728 words	22-06-2012
C25	Beatings, arrest of protesters an outrage	Cape Times (South Africa), NEWS; Pg. 10, 1056 words	25-07-2012
C26	Activists and Politicians Argue Over Violent Protests	GroundUp, 1261 words	08-08-2012
C27	All cisterns go in challenge to rethink the loo	Metro (UK), NEWS; Pg. 18, 268 words	16-08-2012
C28	South Africa;Department of Human Settlements Is Fudging Sanitation Figures	Africa News, 363 words	17-08-2012

C29	South Africa;The Western Cape Government's Delivery to Poor Communities	Africa News, 4633 words	30-08-2012
C30	Social Justice Coalition contests Presidency report on sanitation	Cape Times (South Africa), NEWS; Pg. 3, 384 words	10-09-2012
C31	South Africa;DA Calls On President to Support Sanitation Investigation Request	Africa News, 195 words	14-09-2012
C32	City surpasses its toilet and tap targets	Cape Times (South Africa), NEWS; Pg. 5, 343 words	19-09-2012
C33	City fails to acknowledge problems with janitorial services	Cape Times (South Africa); Pg. 10, 674 words	27-09-2012
C34	Khayelitsha residents kick up a stink over shoddy facilities	Cape Times (South Africa), NEWS; Pg. 6, 1180 words	14-11-2012
C35	No Headline In Original	Cape Times (South Africa); Pg. 10, 524 words	16-11-2012
C36	NGO works for betterment of sanitation facilities	NGO Daily News, 189 words	21-11-2012
C37	Hackers, sanitation experts meet to program an ablution clean-up	The Mercury (South Africa), NETWORK; Pg. 9, 425 words	05-12-2012
C38	South Africa;Chronic Underspending Denying Rural Households Access to Sanitation	Africa News, 403 words	07-03-2013
C39	Diarrhoea still kills;Of more than 22 000 children treated in the ǀW Cape, 30 have died in the last four months	Cape Argus (South Africa), NEWS; Pg. 12, 535 words	10-04-2013
C40	Vandalism costing ǀcity R80m ǀa year	Cape Argus (South Africa), NEWS; Pg. 11, 315 words	15-04-2013
C41	The buckets don't stop here: Toilet trials and tribulations in the Cape	Mail & Guardian, NATIONAL, 1522 words	26-04-2013
C42	Khayelitsha up in arms over toilets	Sowetan (South Africa), SOCIAL ISSUES, 350 words	29-04-2013
C43	South Africa;Khayelitsha Toilet Contractors Not Delivering	Africa News, 1011 words	30-04-2013
C44	City, contractor failing community	Cape Times (South Africa); Pg. 11, 787 words	10-05-2013
C45	City would be ill-advised to flush away the results of Khayelitsha social audit	Cape Times (South Africa); Pg. 11, 825 words	10-05-2013
C46	city vows that hundreds of bucket toilets will go;Mayor says it is regrettable that many reject temporary portable toilets	Cape Argus (South Africa), NEWS; Pg. 7, 510 words	13-05-2013
C47	Communities 'reject toilets'	Business Day (South Africa), SOCIAL ISSUES, 447 words	13-05-2013
C48	De Lille ǀannounces ǀportable ǀloo roll-out	Cape Times (South Africa), NEWS; Pg. 3, 422 words	13-05-2013
C49	South Africa;Cape Town's Portable Flush Toilet Campaign Should Be Implemented in Moqhaka	Africa News, 400 words	14-05-2013
C50	30 000 PEOPLE IN CITY lack basic SANITATION';Coalition welcomes city's plan to eradicate the bucket toilet system	Cape Argus (South Africa), NEWS; Pg. 12, 383 words	14-05-2013
C51	No Headline In Original	Cape Times (South Africa); Pg. 8, 493 words	15-05-2013
C52	City's efforts undermined by severe sanitation backlog	Cape Argus (South Africa); Pg. 22, 513 words	16-05-2013
C53	Danger of scoring political points in toilet wars	Business Day (South Africa), OPINION & EDITORIAL, 746 words	20-05-2013
C54	Striking ǀsanitation workers cause ǀN2 chaos	Cape Times (South Africa), NEWS; Pg. 4, 459 words	21-05-2013
C55	South Africa;ANCYL Ungovernability Campaign Stinks	Africa News, 322 words	05-06-2013

C56	South Africa;Mayor and SJC Clash Over Toilet Facts	Africa News, 950 words	05-06-2013
C57	HRC weighs into fray over bucket toilets	Cape Times (South Africa), NEWS, 248 words	06-06-2013
C58	Complain to us more, says De Lille;Mayor gets message across at Seawinds without disturbance	Cape Argus (South Africa), NEWS; Pg. 2, 528 words	07-06-2013
C59	Protests reveal strong feelings about sanitation issue	Business Day (South Africa), SOCIAL ISSUES, 911 words	10-06-2013
C60	Mother City loos seen as a risk to health	The Star (South Africa), NEWS; Pg. 4, 352 words	10-06-2013
C61	Protesters dump faeces in city centre again after 184 are arrested at station	Cape Times (South Africa), NEWS; Pg. 1, 401 words	11-06-2013
C62	South Africa;DA to Report Sanitation Issues in Meadowlands, Soweto, to HRC	Africa News, 245 words	12-06-2013
C63	South Africa;Portable Flush Toilets - What Are They and Why the Fuss?	Africa News, 1217 words	12-06-2013
C64	Members deserve awards for poo protest, says ANCYL	Mail & Guardian, NATIONAL, 788 words	13-06-2013
C65	South Africa;0.4 Percent of SA's Bucket Toilets in the Western Cape	Africa News, 295 words	13-06-2013
C66	Types of toilets in use around the city	Cape Times (South Africa), NEWS; Pg. 6, 411 words	14-06-2013
C67	ANC threatens standstill	Business Day (South Africa), POLITICS, 556 words	14-06-2013
C68	Activists 'not pleasing any leader, including Zuma'	Sowetan (South Africa), HUMAN INTEREST, 485 words	18-06-2013
C69	Throwing excrement in Cape Town: the DA has reason to feel miffed, but the situation is best explained by the Davies J-curve	Nic Borain Politics and Investment, 1069 words	18-06-2013
C70	ANCYL wants to sabotage toilet service before polls'	Cape Argus (South Africa), NEWS, 484 words	18-06-2013
C71	South Africa;Toilets - What's All the Flush About? a Groundup Q&a	Africa News, 2236 words	25-06-2013
C72	De Lille, SAHRC in war of words over toilet woes	Cape Argus (South Africa), NEWS; Pg. 9, 219 words	25-06-2013
C73	South Africa;Activists to De Lille - Give Us Toilet Plan in Two Weeks	Africa News, 420 words	25-06-2013
C74	City given three months to resolve 'crisis'	Cape Argus (South Africa), NEWS; Pg. 5, 494 words	26-06-2013
C75	Protestors dump human waste at airport	Daily Dispatch (South Africa), HUMAN INTEREST, 241 words	26-06-2013
C76	Coalition statements on sanitation 'dismay' city	Cape Times (South Africa), NEWS; Pg. 3, 235 words	26-06-2013
C77	Poo protesters hit airport	Sowetan (South Africa), SOCIAL ISSUES, 323 words	26-06-2013
C78	City given two weeks to come up with a loo plan	Cape Times (South Africa), NEWS; Pg. 3, 227 words	26-06-2013
C79	faeces protesters face charges of public violence;State opposes bail for expelled ANC suspects behind airport faeces dump	Cape Argus (South Africa), NEWS; Pg. 6, 356 words	27-06-2013
C80	City is dodging sanitation duty, says coalition	Cape Times (South Africa), NEWS; Pg. 8, 233 words	28-06-2013
C81	An attack on the whole population'	Cape Argus (South Africa), NEWS; Pg. 6, 260 words	28-06-2013
C82	poo protest pioneer;Founder of faeces flinging laments 'politicisation' of sanitation wars in Cape Town	Cape Argus (South Africa), NEWS; Pg. 8, 528 words	01-07-2013
C83	Dumping poo the only way, say residents	Sowetan (South Africa), HUMAN INTEREST, 368 words	01-07-2013

C84	How poo became a political issue	Cape Times (South Africa); Pg. 9, 1753 words	02-07-2013
C85	Apartheid stunts delivery'	The New Age (South Africa), 476 words	08-07-2013
C86	Khayelitsha residents demand toilet information	Mail & Guardian, ENVIRONMENT, 670 words	11-07-2013
C87	Poo protest goes out early	The New Age (South Africa), 480 words	30-07-2013
C88	South Africa;340 000 EC Learners Go to School Without Proper Toilets	Africa News, 374 words	06-08-2013
C89	Thumbs up for Cape Town in services survey	The Times (South Africa), HUMAN INTEREST, 207 words	28-08-2013
C90	ANCYL to continue poo protest after names given	The Star (South Africa), NEWS; Pg. 4, 473 words	02-09-2013
C91	Poo fighters deserve the full might of the law	Cape Argus (South Africa); Pg. 16, 550 words	06-09-2013
C92	City nixes solar loo tested in township	Cape Times (South Africa), NEWS; Pg. 3, 441 words	06-09-2013
C93	Police arrest chained sanitation protesters	Cape Argus (South Africa), NEWS; Pg. 8, 305 words	12-09-2013
C94	Lobby group vows to step up action in 'toilet wars'	Business Day (South Africa), POLITICS, 739 words	13-09-2013
C95	Activists question loo policy document	Cape Times (South Africa), NEWS; Pg. 4, 440 words	13-09-2013
C96	South Africa;What Is the Role of Civil Disobedience in South Africa?	Africa News, 1411 words	18-09-2013
C97	South Africa;Human Settlements Neglecting Rural Communities	Africa News, 338 words	02-10-2013
C98	No Headline In Original	Cape Times (South Africa); Pg. 8, 492 words	08-10-2013
C99	South Africa;Human Settlements Shifts Goal Posts for Sanitation Backlog Deadline, Again	Africa News, 408 words	13-10-2013
C100	Cape Town chaos as protest turns violent;Poo fighters accused of leading breakaway group	The Star (South Africa), NEWS; Pg. 4, 466 words	31-10-2013
C101	Protests hit Cape Town's reputation	Sunday Times (South Africa), CRIME, LAW & JUSTICE, 226 words	03-11-2013
C102	ANC billboard's sanitation claim is false	Mail & Guardian, NATIONAL, 479 words	12-11-2013
C103	South Africa;Stevens Mokgalapa, Shadow Minister of Human Settlements	Africa News, 260 words	12-11-2013
C104	Residents say they've much to march for	Cape Times (South Africa), NEWS; Pg. 3, 450 words	29-11-2013
C105	Sanitation issues need to be solved'	Cape Times (South Africa), NEWS, 451 words	06-12-2013
C106	Informal settlement sanitation protest to go ahead without religious leaders	Cape Times (South Africa), NEWS; Pg. 1, 252 words	24-01-2014
C107	Toilets 'would help to flush away crime'	Cape Times (South Africa), NEWS; Pg. 6, 292 words	27-01-2014
C108	Face-to-face opportunity lost	Cape Times (South Africa); Pg. 9, 1396 words	11-02-2014
C109	ANC councillor appeals sacking after poo protests	Mail & Guardian, NATIONAL, 561 words	14-02-2014
C110	12 arrested in illegal march chaos;Further action over housing and sanitation conditions threatened	Pretoria News (South Africa), NEWS; Pg. 4, 600 words	28-02-2014
C111	South Africa;Election Special - What the DA Promises Cape Town's Majority	Africa News, 1087 words	09-04-2014
C112	No Headline In Original	Cape Times (South Africa); Pg. 8, 339 words	09-04-2014

C113	South Africa;Election Special - ANC Says It Will Win Back the People's "Trust"	Africa News, 917 words	10-04-2014
C114	South Africa;Election Special - EFF Promises to Double Social Grants If Elected	Africa News, 835 words	11-04-2014
C115	Zille out of line on portable loos, says ANC	Daily Dispatch (South Africa), POLITICS, 388 words	23-04-2014
C116	Minister praises leaders of poo protests	Cape Times (South Africa), NEWS; Pg. 4, 362 words	28-04-2014
C117	Activists' loo survey at rock bottom;Residents of posh Cape Town suburb turn up noses at group	The Star (South Africa), NEWS; Pg. 5, 559 words	29-04-2014
C118	South Africa;Porta Potties Hit Bishopscourt	Africa News, 688 words	30-04-2014
C119	We won't fling poo anymore, activists promise	Cape Times (South Africa), NEWS; Pg. 1, 237 words	02-05-2014
C120	Basic services roll-out by city	The New Age (South Africa), 365 words	23-05-2014
C121	Nkohla and Lili are using poor to drive their political agendas	Cape Argus (South Africa); Pg. 16, 865 words	03-06-2014
C122	Human Rights;Cape Town's Chemical Toilets 'Violate Human Rights'	Africa News, 594 words	16-07-2014
C123	Cape won't sit for HRC	The Times (South Africa), SOCIAL ISSUES, 366 words	16-07-2014
C124	Cape Town suffers double setback on the lavatorial front line	Business Day (South Africa), POLITICS, 368 words	17-07-2014
C125	South Africa;De Lille Lashes Out At HRC and SJC Over Sanitation Report	Africa News, 603 words	17-07-2014
C126	COMMISSION FINDS CAPE TOWN CITY GUILTY OF DISCRIMINATION	Sowetan (South Africa), CRIME, LAW & JUSTICE, 487 words	17-07-2014
C127	City violates human rights'	Cape Times (South Africa), NEWS; Pg. 1, 711 words	17-07-2014
C128	Porta potties are racist - HRC;Report slams chemical toilets that 'significantly and adversely affect black Africans'	Cape Argus (South Africa), NEWS; Pg. 4, 852 words	17-07-2014
C129	No Headline In Original	Sowetan (South Africa), DEFAULT, 510 words	18-07-2014
C130	SAHRC Backs Battle for Basic Services in Cape Town	The Daily Vox, 765 words	18-07-2014
C131	Mayor slams human rights report	Cape Times (South Africa), NEWS; Pg. 3, 770 words	18-07-2014
C132	South Africa;Magistrate Says Charges Stand Against Sanitation Activists	Africa News, 391 words	24-07-2014
C133	Other metros must also be labelled racist'	Cape Times (South Africa), NEWS; Pg. 3, 423 words	24-07-2014
C134	Social audits involve communities in issues that affect them	Cape Times (South Africa); Pg. 11, 844 words	01-08-2014
C135	Africa;Data to the People!	Africa News, 1629 words	14-08-2014
C136	R1bn roll-overs slated;It's not underspend, it's delayed spend, DA administration tells opposition	Cape Argus (South Africa), NEWS; Pg. 3, 486 words	21-08-2014
C137	City lashes 'hostile' NGO over toilet saga;Social Justice Coalition claims R60m ratepayer funded service is failing	Cape Argus (South Africa), NEWS; Pg. 9, 479 words	01-10-2014
C138	Toilet saga timeline	Cape Argus (South Africa), NEWS; Pg. 8, 209 words	02-10-2014
C139	Revealing toxic toilet reality to change lives	Cape Argus (South Africa), NEWS; Pg. 8, 466 words	04-10-2014
C140	Dying to use the toilet	Sowetan (South Africa), HUMAN INTEREST, 151 words	08-10-2014
C141	Your indignity in the townships is just as much my indignity in the suburbs	Cape Times (South Africa); Pg. 9, 782 words	08-10-2014

C142	South Africa;SJC Trial - 'We Wanted the City to See We Were Serious'	Africa News, 648 words	08-10-2014
C143	Taking up the gauntlet	to improve people's lives;Designers display their solutions for low-cost and environmentally friendly home environments at the Better Living Challenge Showcase	Cape Argus (South Africa); Pg. 13, 1133 words	05-11-2014
C144	South Africa;Poor Sanitation and Lousy Maps Contribute to Khayelitsha's Crime Problems	Africa News, 766 words	11-11-2014
C145	Making Do With Public Toilets in Khayelitsha [analysis]	The Daily Vox, 904 words	19-11-2014
C146	Data-driven activism empowering	Cape Times (South Africa); Pg. 11, 1687 words	15-12-2014
C147	We will not accept convictions of our members'	Cape Argus (South Africa), NEWS; Pg. 6, 354 words	06-02-2015
C148	Ses'Khona planning protest against poor sanitation	Cape Times (South Africa), NEWS; Pg. 4, 222 words	11-02-2015
C149	Human Rights;Human Rights Commission to Probe City Toilets Again	Africa News, 653 words	05-03-2015
C150	Toilet 'indignity' remains an issue	Cape Times (South Africa), NEWS; Pg. 5, 360 words	06-03-2015
C151	The symbolic statue dividing a South African university	Yerepouni Daily News, 1306 words	25-03-2015
C152	South Africa;Countrywide Protests By Education Activists Over Delayed Government Plans	Africa News, 776 words	02-04-2015
C153	South Africa;More Toilets Will Save South Africa Money	Africa News, 831 words	29-04-2015
C154	Improved sanitation may reduce sexual violence in South African townships	US Official News, 501 words	01-05-2015
C155	South Africa;Lukewarm Response to New Khayelitsha Toilets	Africa News, 476 words	25-05-2015
C156	Frenzy over R37.5bn budget;Mayor Patricia de Lille demands longer hours to assess all public submissions	Cape Argus (South Africa), NEWS; Pg. 4, 584 words	25-05-2015
C157	South Africa;"Not Enough Money Allocated to Sanitation," Say SJC Protesters	Africa News, 304 words	28-05-2015
C158	South Africa;Campaigning for Clean Toilets and Good Cops - an Interview With the SJC's Axolile Notywala	Africa News, 2642 words	21-08-2015
C159	South Africa;Special Audit Finds Over R700 Million Unspent On Building Toilets for the Poor	Africa News, 422 words	21-08-2015
C160	South Africa;Poor Chemistry Between City and Community Over Sanitation Contract	Africa News, 563 words	25-08-2015
C161	South Africa;No Justification for Rural Households Infrastructure Grant Contract Mess, Says Scopa	Africa News, 324 words	01-09-2015
C162	SOUTH AFRICA RESEARCH FELLOWSHIP PROMOTES SOCIAL CHANGE AND GLOBAL PARTNERSHIPS	States News Service, 1190 words	11-09-2015
C163	R5 000 for student who shows innovation	Cape Times (South Africa); Pg. 8, 270 words	23-02-2016
C164	South Africa;Khayelitsha Residents in Stand-Off With City	Africa News, 581 words	29-04-2016
C165	We're too scared to use the toilets'	Cape Argus (South Africa), NEWS; Pg. 8, 262 words	30-04-2016
C166	South Africa;City Replies to Budget Criticism	Africa News, 821 words	05-05-2016

C167	South Africa;Mayor Handed Sanitation Petition On Eve of Budget Speech	Africa News, 433 words	24-05-2016
C168	Budget of 2 cities' lashed	Cape Times (South Africa), NEWS; Pg. 1, 597 words	26-05-2016
C169	Cape trails in toilet facilities drops	Cape Times (South Africa), NEWS, 545 words	20-06-2016
C170	South Africa;City Taken to Court Over Toilets	Africa News, 1105 words	04-07-2016
C171	South Africa;City Snubs Khayelitsha Meeting On Toilets	Africa News, 565 words	01-08-2016
C172	Poo thrower now city's protest negotiator	The Times (South Africa), POLITICS, 386 words	21-09-2016
C173	Pupils busting for the loo	The Times (South Africa), HUMAN INTEREST, 382 words	21-09-2016
C174	DEATHS THE RESULT OF POOR SANITATION	Sowetan (South Africa), HUMAN INTEREST, 423 words	24-11-2016
C175	South Africa;Blocked Toilets Make Life Unbearable for Masiphumelele Wetlands Residents	Africa News, 320 words	12-05-2017
C176	Call for proper sanitation policy	Cape Times (South Africa); Pg. 9, 914 words	30-05-2017
C177	South Africa;Pelican Park Erupts After Councillor Goes Awol	Africa News, 608 words	27-07-2017
C178	Lensman brings indignities from lack of sanitation into plain sight	Business Day (South Africa), ARTS, CULTURE & ENTERTAINMENT, 1144 words	16-08-2017
C179	De Lille promises to sort out sanitation;Weekly communication with Masiphumelele residents part of solution	Cape Argus (South Africa), NEWS; Pg. 2, 265 words	01-09-2017
C180	Lack of toilets more than an inconvenience	Sowetan (South Africa), HUMAN INTEREST, 726 words	16-10-2017
C181	Citizens Alliance will keep pushing for equality for all	Cape Times (South Africa); Pg. 8, 632 words	01-11-2017
C182	City, police in court for lack of services	Argus Weekend (South Africa), NEWS; Pg. 6, 797 words	12-11-2017
C183	The new alchemy of human waste	Cape Times (South Africa); Pg. 9, 1123 words	15-11-2017
C184	DROUGHT - City will ensure sewers continue to function	Business Day (South Africa), SOCIAL ISSUES, 375 words	25-01-2018
C185	South Africa;Landmark Court Ruling On Protests Is a Victory for Citizens	Africa News, 1219 words	05-02-2018
C186	Day Zero could have devastating health effects for Cape Town citizens	Cape Argus (South Africa); Pg. 18, 649 words	17-02-2018
C187	Day Zero double whammy in rising disease risk	The Sunday Independent (South Africa), NEWS; Pg. 2, 626 words	18-02-2018
C188	South Africa;One Year After Hout Bay Fire Residents Sit Without Basic Services	Africa News, 441 words	26-03-2018
C189	After Children Die in Pit Toilets, South Africa Vows to Fix School Sanitation	The New York Times , WORLD; africa, 934 words	14-08-2018
C190	Tech-savvy Winde eyes growth;Premier candidate aware of the challenge	Argus Weekend (South Africa); Pg. 6, 424 words	23-09-2018
C191	How increasing the number of toilets can reduce violence against women	telegraph.co.uk, NEWS; Version:1, 553 words	08-11-2018
C192	CONSTITUTIONAL COURT - Top court strikes strong blow for peaceful protest	Business Day (South Africa), CRIME, LAW & JUSTICE, 365 words	20-11-2018
C193	Free basic services listed	Cape Argus (South Africa); Pg. 4, 342 words	30-08-2019

C194	How our urine and faeces can be used to fuel growth and create a cleaner environment	Mail & Guardian, OPINION, 1210 words	23-11-2019
C195	MEC Bredell responds to ANc	Cape Times (South Africa); Pg. 8, 669 words	20-02-2020
C196	Concern as education share is cut	Sowetan (South Africa), EDUCATION; Pg. 6, 548 words	27-02-2020
C197	Social justice bodies plead for halt to evictions amid Covid-19 threat	Hazyview HeraldNEWS, 629 words	24-03-2020
C198	How do we lockdown?	MSN South Africa NEWS, 839 words	02-04-2020

Appendix C List of Reports

Municipality	Title	Year	Pages
City of Cape Town	Integrated Development Plan Annual Review 2011-2012	2011	236
City of Cape Town	Water Services Departmental Sector Plan 2012-2017	2015	70
City of Cape Town	Integrated Development Plan 2012-2017 (2016/17 Review and Amendments)	2016	172
City of Cape Town	Integrated Development Plan 2017-2022	2017	149
eThekwini	Integrated Development Plan 2011/2012	2011	251
eThekwini	Water Services Development Plan	2011	138
eThekwini	Integrated Development Plan Annual Review 2016/2017	2016	544
eThekwini	Integrated Development Plan Annual Review 2019/2020	2019	949

Appendix D List of Interviewees

Number	Interviewed on	Role	Type of organization
1	eThekwini	Former Head	Water & Sanitation Department
2	eThekwini	Municipal Official	Municipality
3	eThekwini	Head of Research Group	Knowledge Institute
4	eThekwini	Sanitation Research Scientist	Knowledge Institute
5	City of Cape Town	Municipal Official	Municipality
6	Both	Sanitation Research Scientist	Knowledge Institute
7	Both	Water Sector Analyst	Government
8	Both	Professor Sociology & Social Anthropology	Knowledge Institute
9	Both	Consultant & Sanitation Researcher	Knowledge Institute
10	Both	Manager	NGO
11	Both	Director	Private Sector Company

Appendix E Interview Guide

Firstly, I would like to introduce myself and my thesis research. After that, we can start the interview with an introduction of yourself and your relation to the topic.

Introduction Thesis Research
I am Jordi Maijenburg, I study Innovation Sciences at the Utrecht University in The Netherlands. This master study focuses on innovation as a tool for sustainable economic growth and to help tackle societal problems.

My master thesis focuses on decentralized sanitation sector in the City of Cape Town and eThekwini in the last ten years. I am especially interested in their innovation processes regarding decentralized sanitation solutions.

Over the past few months, I have coded and analyzed news articles and policy reports on this topic (as a replacement for my originally scheduled fieldwork). With these expert interviews, I would like to validate the findings from that analysis and add new relevant data to it. I am especially interested in the roles of the different actors, the influence of politics and the social acceptance from society of the different solutions. From what I've found, it seems like the acceptance of the different solutions is an issue in both municipalities, we'll come to that later.

Do you have any questions about the research at this point?

Structure interview
This interview will take approximately 1 hour. I have many questions so it might happen that I interrupt you during this interview to make sure there is enough time to discuss all relevant aspects. Furthermore, I would like to record this interview to be able to transcribe it later and make sure I do not miss any relevant parts during analysis. I will delete the recording after transcribing and the transcript from the interview will be anonymized. Do you agree to this?

During the interview, I might ask questions about subjects that are not within your sphere of expertise. Please let me know and we will continue to other questions.

General
1. I learned that you are POSITION at WHERE. Could you please elaborate a bit further about yourself and your role in relation to the decentralized sanitation sector in the City of Cape Town and/or eThekwini and your current employment?
2. During what years were you involved in decentralized sanitation in the City of Cape Town and/or eThekwini?

Questions specifically for municipal officers

3. How is the water & sanitation department structured?
    a. Which departments are involved?
    b. How are the responsibilities divided?
4. How are policies and regulations formed?
5. How are projects funded?
6. What types of decentralized solutions have been piloted in the past ten years?
7. Does the municipality have (continuous) partnerships?
    a. How are these formed?

Decentralized Sanitation (Structure, i.e. actors, networks, etc.)

8. Who are the main players in the area of decentralized sanitation in both municipalities, according to you? Is there a key actor?
9. Which role do these players have in this area?
10. Has this field of players changed over time, if so, how?
11. If not discussed: What is the role of:
    a. National, provincial, municipal government
    b. NGOs
    c. Civil society
    d. Knowledge Institutes
    e. Private Sector

Innovation processes

Let me quickly explain how I have operationalized innovation in my thesis, so that we can be sure we'll be talking about the same thing during this interview. I understand innovation as the process of knowledge development and diffusion, but I consider more aspects. For innovation to be successful there should also be market formation, a vision, policies and regulations, legitimation work to create acceptance and a good quality and quantity of resources. In a systemic perspective, we consider actors, networks of actors and the formal and informal rules as the structure of the innovation system. Their interplay determines how well the different aspects of innovation are dealt with.

12. How do you feel about the innovativeness in this area in the municipality?
13. Over the time period you were involved in this area, do you feel innovativeness has increased, stayed the same or decreased?
    a. Why would you say so?
    b. Which players drove this increase/decrease?
    c. What were the main drivers for increase/decrease?

TIS results (actors)

14. In both municipalities, the government seems to be the main driver for development, with little involvement of the private sector. Why do you think this is the case?
15. The NGO Social Justice Coalition has been very active in the sector in the City of Cape Town. Do you think they contribute positively to innovative development in the sector? If so, how? If not, why not?

16. It seems that knowledge institutes are almost absent in the overall development of the sanitation sector in the City of Cape Town. Why do you think this is the case? How would you interpret their contribution?
17. The NGO Bill & Melinda Gates Foundation seemed to have contributed to many aspects of the innovation system around decentralized sanitation solutions and one of the core drivers of the development in eThekwini. How would you interpret their contribution?
18. If knowledgeable on both municipalities/NGOs: How would you compare the contribution of the NGOs SJC and the Gates Foundation?
19. The University of Kwa-Zulu Natal was coined as the sanitation hub of Africa and Durban became a test site for many pilot projects. Did this accelerate development? If so, how?

TIS results (overall development)

20. There seems to be a big difference in development in Cape Town and eThekwini. From the news articles, I have found that in Cape Town more than half of the news events contributed negatively to the development, while in eThekwini this is less than a quarter of the events. Furthermore, in eThekwini we see a wider development, more aspects important to innovation are covered (such as resources, market formation, private sector involvement, knowledge development etcetera). How do you explain the difference between these municipalities?
21. From 2015 onwards, it seems from the news articles that a lot of important aspects, such as knowledge development, private sector activities and mobilization of financial resources came to a halt in the City of Cape Town. Did you also notice this? How can this be explained?
22. From 2018 onwards, drought became a major issue in the City of Cape Town, followed by the coronavirus in 2020. Did this shift the focus from sanitation? Do you think this influenced the overall development? How?
23. From 2015 onwards, we could see some negative development in terms of legitimacy in eThekwini, but also knowledge development and diffusion, there also seemed to be less guidance of the municipality in terms of what technologies to develop and pilot. What is your explanation for these negative developments?

TIS results (politics)

24. What is the role of politics in the area of decentralized sanitation innovations?
25. How does this influence the overall innovativeness of the sector, according to you?
26. It seems like the sanitation sector in the City of Cape Town is heavily politized, also relative to other municipalities. How can we explain this difference? (if not discussed, ask about misalignment between national/provincial/municipal government)
27. In comparison to Cape Town, I could not find any events related to data validity or a disbelief in governmental capabilities in eThekwini. Also, there was less grouping of actors to negatively influence the development

of decentralized sanitation solutions. Can we assume that there are less trust issues?

TIS results (legitimacy)

28. When we compare the City of Cape Town and eThekwini in terms of legitimation, we find that only a quarter of the events in the City of Cape Town relate to legitimation activities that contribute positively to the overall development. In eThekwini, this is almost over half of the events. Furthermore, in the City of Cape Town we see more protests, political work and a lower social acceptance. Do you agree to these findings? Why do you think there is this difference?
29. If not discussed: what does the municipality do to increase acceptance for the decentralized solutions?
30. There is more involvement of the community in the implementation of the solutions reported in eThekwini than in the City of Cape Town. Do you think this is an important aspect? If so, how does it contribute to the overall development?
31. The introduction of the portable flush toilets in 2013 in the City of Cape Town caused a lot of protests. What do you think caused these protests? Did these protests contribute to an increase of innovative development or not? How?
32. From the news articles, it seems that there are not too many protests in eThekwini, especially compared to Cape Town. Why do you think there are relatively little protests in eThekwini? Can we conclude there is overall more social acceptance and if so, why?
33. Over the years, there seems to be a shift in actors who do the most legitimation work in eThekwini. During 2011-2013, NGOs contributed mostly, after which the private sector also got involved. How would you interpret this shift? In which years did these companies enter the field and why? Was there any specific new project that opened up business opportunities (international/local)?

Prospects of the sector

34. How do you see the (near) future development of decentralized sanitation in the City of Cape Town and/or eThekwini?
35. What makes you believe this will happen? What factors will play the most decisive role?

Ending

36. Do you think there is someone else I should contact based on our interview?
37. Would you like a copy of the thesis when it is finished?

Appendix F Coding Scheme Event Analysis

Structural elements

Category	Element	Description (based on Bergek et al. (2008) and Suurs and Hekkert (2009))	# of events
Actors	Civil Society	Citizens and communities, often users of the technologies	159
	Government	All governmental spheres and organizations (such as political parties, commissions etc.)	409
	Jurisdiction	Legal organizations	40
	Knowledge Institutes	Universities, technology institutes, research centers, schools	57
	NGOs	Non-governmental organizations	159
	Private Sector	Companies that are not under direct state control	43
Institutions	*Formal:* Instructions	Instructions provided by governmental organizations to other actors	5
	Formal: Laws	A rule of conduct or action which is binding and enforced by a controlling authority	10
	Formal: Regulations	Rules to regulate markets, maintained by a controlling authority	2
	Informal: Established practices	General practices of actors that are not forced upon them by a controlling authority	60
	Informal: Expectations	Expectations of the various actors regarding directionality of development	13
	Informal: Norms	What is considered as the standard by actors	29

Functions

Function	Activity	Description (based on Suurs and Hekkert (2009))	+/-	# of events
F1. Entrepreneurial activities	Project exit-failure	Exploration activities are cancelled	-	3
	Service providers	Actors providing services in the sanitation value chain	-	24
	Portfolio expansion	A (vested) actor explores activities without any previous experience	+	1
	Project entry-start	Technology is explored within a societal context and/or with a commercial goal	+	47
F2. Knowledge Development	Knowledge Networks	Research collaborations between various actor types	+	18
	Learning by doing	Practical research with no direct commercial orientation	+	17
	Learning by exploring	Assessment research with no direct commercial orientation	+	9
	Opinion	Actors' critical notes on institutions and/or past developments.	+	12

F3. Knowledge Diffusion	Education	Educating actors in the TIS on technological solutions	+	19
	Meetings	Workshops, conferences, etc.	+	68
F4. Guidance of the Search	Doubt or uncertainty	Expression of the technology's uncertain circumstances	-	5
	Expectations negative	Negative expressions of the technology's future expectations	-	10
	Outcome study negative	Negative results of research and trials	-	29
	Promises or targets negative	Promises by actors with the power to change institutions, hampering the technology	-	4
	Standard setting negative	Setting (international) standards that inhibit positive TIS development	-	1
	Unmet promises or targets	Promises/targets were made by influential actors, but were not met	-	20
	Expectations positive	Expression of the technology's future expectations.	+	30
	Outcome study positive	Positive results of research and trials, often mentioned when reports are published	+	25
	Plans	Presenting plans with timelines for technological solutions	+	9
	Promises or targets positive	Promises by actors with the power to change institutions, complementing the technology	+	61
	Standard setting positive	Setting (international) standards that accelerate positive TIS development	+	10
F5. Market Formation	Maintenance and Refuse Removal positive	Lack of provision of maintenance and refuse removal for new technological solutions	-	78
	Niche markets	Protected spaces where practical experiments can be conducted in a market environment	+	17
	Maintenance and Refuse Removal negative	The provision of maintenance and refuse removal for new technological solutions	+	5
F6. Resources Mobilization	Corruption	Using subsidies and funding for other means than intended	-	8
	Not enough resources available	Constraints on provision of resources	-	13
	Resource refusal	Rejection of financial support and cutbacks	-	4
	Underspending	Not spending subsidies or funding on plans presented	-	17
	Investments and subsidies	Including dedicated subsidy programs	+	52
F7. Legitimation	Advocacy	The mobilization of political and regulatory support	-	20
	Changing normative associations	The connection process of new sets of practices with moral and cultural foundations	-	5

	Community participation	The inclusion or exclusion of communities in decisions affecting communities	-	54
	Constructing normative networks	The construction of inter-organizational connections in order to normatively sanction practices and monitor and evaluate developments	-	1
	Doubting data validity	Doubting the validity of data provided by actors	-	36
	Demonizing	The provision of negative examples to illustrate normative foundation	-	2
	Disbelief in governmental capabilities	Stating that the government will not be able to fulfill promises due to a lack of capabilities	-	11
	Framing discourses	Providing frames that give meaning to an issue or solution by connecting theories about what happens and what matters (Druckman, 2001)	-	24
	Imagery	The use of images to associate an issue with danger of pleasing experiences	-	27
	Legal action	Taking other actors to court over their actions in TIS development	-	54
	Mythologizing	The creation or preserving of certain myths to preserve the normative foundation of institutions	-	9
	Political work	The use of political power in order to shape or maintain institutions	-	99
	Protests	Protests against policies	-	109
	Safety	Focusing on safety aspects	-	71
	Obstructing social acceptance	Hinder that other citizens use the provided solutions	-	58
	Advocacy	The mobilization of political and regulatory support	+	19
	Changing normative associations	The connection process of new sets of practices with moral and cultural foundations	+	37
	Community participation	The inclusion or exclusion of communities in decisions affecting communities	+	43
	Constructing normative networks	The construction of inter-organizational connections in order to normatively sanction practices and monitor and evaluate developments	+	6
	Educating	The process of educating actors with the skills and knowledge to support new practices	+	24
	Framing discourses	Providing frames that give meaning to an issue or solution by connecting theories about what happens and what matters (Druckman, 2001)	+	60

	Mythologizing	The creation or preserving of certain myths to preserve the normative foundation of institutions	+	2
	Creating social acceptance	Support that other citizens use the provided solutions	+	3
	Valorizing	The provision of positive examples to illustrate the normative foundation	+	13

Appendix G Coding Scheme Expert Interviews

Context and key differences

Category	Sub node	References
Context	City of Cape Town history	1
	eThekwini history	5
	Neo-liberal thinking	2
	South Africa history	2
Key differences	Differing needs - drought & waste issues	4
	Forming partnerships	2
	Impact of bureaucracy	1
	Institutional entrepreneurship	1
	Institutionalizing knowledge	2
	Number of protests	1
	Political structure	3
	Private sector involvement	1
	Risk assessment	2
	Structure of municipal services	1
	Topological difference	2
	Trust issues	1
	Working with communities	1

City of Cape Town – actors

Actor Type	Node	References
Knowledge institutes	Not a continuous collaboration	1
Municipality	Change of leadership	1
	Coordination issues	1
	Executive turnover	2
	Impact of bureaucracy	4
	Impact of Covid	3
	Impact of drought	2
	Impact of land invasions	1
	Mostly sewered connections - different needs	3
	Municipal Financial Act	2
	Project-based partnerships	3
	Siloed structure within municipality	3
NGOs	Attitude of municipality towards NGOs	1
	Impact of SJC	1
	NGOs prefer centralized	1
Private Sector	Private Sector as service provider	1

City of Cape Town – functions

Function	Node	References
F1. Entrepreneurial activities	Lack of co-development of solutions	2
F2. Knowledge Development	Difficulties with institutionalizing knowledge	4
	Top-down approach to choosing solutions	1
F4. Guidance of the Search	Dry on-site sanitation not possible	1
	Flush whenever possible	3
	Gathering of new technologies	1
	Impact of landfill ban on type of solutions	1
	Risk aversity	1
F5. Market Formation	Creation of job opportunities	2
F6. Resources Mobilization	Difficult to get funding as local government	1
	Increasing number of households	1
	Less funding in comparison to water supply	1
	No funding for decentralized	1
F7. Legitimation	ANC vs DA - Political work	6
	Citizens prefer individual over shared services	1
	Communication strategies	3
	Conflicting Data	1
	Crises as accelerator	2
	Education challenges	2
	Impact of inequality and power structures	1
	Impact of media backlash on strategies	1
	Involvement of communities	6
	Issues with refuse removal create lack of legitimacy	3
	Social political issues	2

eThekwini – actors

Actor Type	Node	References
Knowledge Institutes	Continuous partnering with municipality	2
Municipality	Central structure for sanitation	1
	Continuous funding through partnerships	2
	Full cycle vision	1
	Impact of retiring institutional entrepreneur	3
	Institutional entrepreneurship	7
	Topological conditions	1
	Urban Development Line	1
NGOs	Influence of Gates Foundation	4
Private Sector	Involvement of local & international private companies	5
	Private companies are needed to go to scale	1

eThekwini - functions

Function	Node	References
F1. Entrepreneurial activities	Co-development of solutions	1
F2. Knowledge Development	Coalitions around full cycle sanitation	1
	Institutionalizing knowledge through long-term partnerships	3
	Sanitation Hub as continuous partner	2
F4. Guidance of the Search	Vision of Ecological Sanitation	4
F5. Market Formation	Banana City housing project	2
F6. Resources Mobilization	Gates Foundation as funding partner	2
F7. Legitimation	Cash incentives	2
	Convince multinationals to use same technologies	1
	Creating job opportunities	1
	Creating solution for all	1
	Crises as accelerators	6
	Customer & stakeholder management	2
	Education challenges	1
	Importance of high-quality user interface	2
	Increasing standards among citizens	1
	Involvement of communities	4
	Lack of need in rural areas	1
	Overcoming the Yuck Factor	1
	Political alignment	1
	Regulator as gatekeeper	1