

**Gordon Institute
of Business Science**
University of Pretoria

**Leveraging information and communication technologies
for effective water stewardship: probing the future
preparedness of water service authorities**

Coenraad Hendrik Loubser

15406823

A research project submitted to the Gordon Institute of Business Science,
University of Pretoria in partial fulfilment of the requirement for the degree of
Master in Business Administration

7 November 2016

ABSTRACT

South Africa is regarded as an arid country but the existing water stewardship practises are inadequate to prevent severe water scarcity in the future that could have a detrimental effect on the country's economy. The biggest regulatory structure of water management in South Africa is the government appointed Water Service Authorities (WSAs). Given modern-day advances in digital technologies, Wang et al. (2015) envisions that tools such as intelligently networked water cyber physical systems could aid in water stewardship practises.

This research aimed to contribute to the existing body of knowledge through identifying the most important water stewardship factors that currently play a role in the environment of WSAs, identifying the envisaged factors that can play a part in the future sustainability and stewardship of water, as well as recognising the opportunities and challenges that could enable or prohibit the implementation of information and communication technologies (ICT). The research adopted an inductive approach to interpret the various responses of 11 semi-structured interviews with water professionals that works within the environment of WSA. It included insights from Government, Water boards (also seen as WSAs), non-government organisation, private sector consultants and research institutions.

A sustainable water balance framework developed by Rozza et al. (2013) was applied to discuss current water stewardship practices. The study shows that planning and strategy, governance and management as well as public perception and awareness were identified as the most important current factors while technology and products are seen as the most important future factors. Most factors in current water stewardship practices were perceived with a negative connotation. Numerous ICT opportunities were identified and outweighed the challenges that are perceived with the implementation of ICT. In probing the future preparedness of WSA for the adoption of information and communication technologies, it was found that there was a vastly positive response. Although many hurdles to the adoption of ICT were identified, more opportunities than challenges were acknowledged. WSA can thus be classified as prepared for the implementation of ICT, should solutions be found for some of the impending problems.

Keywords: Water stewardship, Water service authorities, ICT

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Coenraad Hendrik Loubser

7 November 2016

TABLE OF CONTENTS

LIST OF FIGURES	2
LIST OF ABBREVIATIONS	3
CHAPTER 1: PROBLEM DEFINITION AND PURPOSE	4
1.1 Introduction	4
1.2 Research Motivation	5
1.3 Research Scope	6
1.4 Research Objectives	7
CHAPTER 2: THEORY AND LITERATURE REVIEW	9
2.1 Introduction	9
2.2 Analysis of water scarcity	9
2.3 Relevance of water stewardship	11
2.4 Foresight and strategies	15
2.5 Digital business strategies and Cyber-physical systems	17
2.6 Continuous Change Theory and Cynefin framework.	19
2.7 Conclusions of Literature Review.	20
CHAPTER 3: RESTATEMENT OF RESEARCH QUESTIONS	22
CHAPTER 4: RESEARCH METHODOLOGY	23
4.1 Research Method	23
4.1.1 Rationale for method	23
4.1.2 Research Process	24
4.2 Population and Unit of Analysis	24
4.2.1 Population	24
4.2.2 Unit of analysis	25
4.3 Size and Nature of the Sample	25
4.4 Data Collection, Data Analysis and Data Management	26

4.4.1	Data Collection	26
4.4.2	Data Analysis	27
4.5	Data Validity and Reliability	28
4.6	Potential Research Limitations	30
CHAPTER 5: RESULTS		32
5.1	Introduction	32
5.2	Description of sample and data sorting method	32
5.2.1	Summary of interviews conducted and the interview method	32
5.2.2	Interview transcriptions and verification	36
5.2.3	Transcription coding in ATLAS.ti	36
5.2.4	Details of Respondents interviewed	38
5.3	Transcript Analysis through word counts	40
5.4	Transcript Thematic Analysis	43
5.5	Research Question 1	44
5.5.1	Results for Research Question 1	44
5.5.2	Results for working environments	53
5.5.3	Analysis of perceptions of discussed factors in Research Question 1	59
5.5.4	Conclusion	61
5.6	Research Question 2	62
5.6.1	Results for Research Question 2	62
5.6.2	Future factors identified by working environments	67
5.6.3	Conclusion	69
5.7	Research Question 3	69
5.7.1	Results for Research Question 3	70
5.7.2	ICT Opportunities	70
5.7.3	ICT Challenges	73



5.7.4	Conclusion	77
5.8	The Complexity of the Systems	78
5.8.1	Results for Complexity Factors	78
5.8.2	Conclusions	82
CHAPTER 6: DISCUSSION		83
6.1	Introduction	83
6.2	Research Question 1	83
6.2.1	Findings	83
6.2.2	Discussion	83
6.2.3	Conclusion	92
6.3	Research Question 2	93
6.3.1	Findings	93
6.3.2	Discussion	94
6.3.3	Conclusion	98
6.4	Research Question 3 and the Complexity Theory	100
6.4.1	Findings	100
6.4.2	Discussion	100
6.5	Overall Analysis and Conclusion	104
CHAPTER 7: CONCLUSION		106
7.1	Introduction	106
7.2	Findings	106
7.3	Limitations of the research	108
7.4	Recommendations	109
7.5	Suggestions for future research	110
7.6	Overall Conclusion	111
CHAPTER 8: REFERENCES		112
Appendix 1: Research Questions and Prompts		119

Appendix 2: Job environment word count	120
Appendix 3: ATLAS.Ti funtions	122
Appendix 4: Example of coding	123
Appendix 5: Top ten word counts	126
Appendix 6: Current Factor Coding by Individual	128
Appendix 7: List of Current Factors and share of voice	131
Appendix 8: Current Factor Results for Respective Working Environments	133
Appendix 9: Future factor coding by individual	145
Appendix 10: List of Future Factors and share of voice	147
Appendix 11: Future Factor Results for Respective Working Environments	149
Appendix 12: ICT factor coding by individual	153
Appendix 13: Current Factor Network view.	155
Appendix 14: Future Factor Network view.	156
Appendix 15: Ethical clearance.	157

LIST OF TABLES

Table 1 Data analysis methods for research study	28
Table 2. Respondent information	33
Table 3. Coding convention	37
Table 4. Respondent qualifications and experience	38
Table 5. Top 20 most common words	41
Table 6: Attributes co-occurring with the word "water"	42
Table 7: Highest frequency of codes co-occurring with the word "people".	43
Table 8. Planning and Strategies is the most important current factor.	46
Table 9: Governance and Management is the second most important current factor.	48
Table 10: Public Participation and Awareness is the third most important current factor	51
Table 11: Positive and Negative super-codes for the top ten current factors.	59
Table 12: Technology and Products is the most notable future factors across the sample population.	64
Table 13: Trust and Accountability is the second most notable future factors across the sample population.	65
Table 14: Public participation is the third most notable future factor across the sample population.	66
Table 15: ICT Opportunities and Challenges	70
Table 16: Identification of ICT Opportunities	71
Table 17. Identification of ICT Challenges	74
Table 18. Identification of Complexity factors	79
Table 20: ICT Opportunities and ICT Challenges matched to the identified factors.	101

LIST OF FIGURES

Figure 1. Framework for achieving a sustainable water balance.	13
Figure 2. The Cynefin Framework	20
Figure 3. Data saturation	33
Figure 4: Overall 'share of voice' chart	44
Figure 5: Top ten identified current factors that play a role in current water stewardship practices.	45
Figure 6: Top ten identified future factors that can play a role in future water stewardship practices.	63
Figure 7: The water balance model	84

LIST OF ABBREVIATIONS

AWS:	Alliance of Water Stewardship
CPS:	Cyber-Physical Systems
DBS:	Digital Business Strategies
DT:	Digital Technology
DWS:	Department of Water and Sanitation
GDP:	Gross Domestic Product
ICT:	Information Communication Technologies
IoT:	Internet of Things
IT:	Internet Technologies
NGO:	Non-Governmental Organisations
NWRS:	National Water Resource Strategy
PPP:	Private-Public Participation
RTF:	Rich Text Format
WB:	Water Boards
WSA:	Water Service Authorities

CHAPTER 1: PROBLEM DEFINITION AND PURPOSE

1.1 Introduction

Global water scarcity is a very real and growing problem that is placing our entire existence under threat (Addams, Boccaletti, Kerlin, & Stuchtey, 2009; UNESCO, 2012b; Veolia Water, 2011; WWF, 2013) By 2050, more than half of the global population will be exposed to severe water scarcity as a result of unsustainable practices (Veolia Water, 2011). Not only will this have a massive impact on food and energy production, but 50% of the GDP is expected to fall if water scarcity persists at the current rate (Veolia Water, 2011). This will adversely affect many economies and business across the world. Several international institutions and companies, e.g. World Wide Fund for Nature, World Business Council for Sustainable Development, International Union for Conservation of Nature, and International Food Policy Research Institute amongst others are raising awareness on the impact that future water scarcity may bring to the food-water-power nexus.

Water is an all-over necessity, including domestically, agriculturally and in industrial processes. All water consumers have a responsibility to reduce their ecological footprint, be mindful of the water scarcity and ensure future generations still have access to potable water. Still, the biggest regulatory structure of water consumption is government based Water Service Authorities (WSA), thus targeting them, and implementing information and communication technologies (ICT) on municipal level, will have a cascading effect on all other water consumers. WSAs (the government) are therefore burdened with the great responsibility of proper water resource and consumption management (UNESCO, 2009).

A lot of interest on this contentious subject is currently being placed on water stewardship (Rozza et al., 2013; WWF, 2013). Water stewardship is defined by the Alliance for Water Stewardship (AWS) Standard as the “use of water that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process” (Imane et al., 2013, p. 5). Other than water stewardship, literature also focusses on other vital topics like water governance and ethics (Groenfeldt & Schmidt, 2013), deployment of smart metering

and intelligent networks (Beal & Flynn, 2015; Stewart, Willis, Giurco, Panuwatwanich, & Capati, 2010), water policy (Hepworth, 2012) and creation of shared value (Orr & Sarni, 2015).

This research paper will focus on how WSAs could enhance their water stewardship strategy by implementing ICT like digital technologies (DT). Bharadwaj, El Sawy, Pavlou, and Venkatraman (2013), Setia, Venkatesh, and Joglekar (2013) and Drnevich and Croson (2013) argue that DT are fundamentally transforming the way business operates viz. increased interconnections among products, processes, services and an emphasis on becoming customer-centric organizations. While DT disrupts many traditional business practices it also provides numerous business opportunities across a variety of industries (Bradley, Loucks, Macaulay, Noronha, & Wade, 2015; Utesheva, Simpson, & Cecez-Kecmanovic, 2015; Wenzel, Wagner, Wagner, & Koch, 2015). Given modern-day advances in science and DT Wang et al.(2015) envisions that tools such as the intelligently networked water cyber-physical system (CPS) could aid water stewardship practices.

CPS is defined as “intelligently networked systems with embedded sensors, processors, and actuators that are designed to sense and interact with the physical world (including human users), and support real-time, guaranteed performance in safety-critical applications” (Wang et al., 2015). Regrettably, the water-utility industry, a traditional offline business, is said to be one of the last industries that will undergo digital disruption (Bradley et al., 2015; Deloitte, 2012). To date, research around how South African WSAs exercise their foresight to define the strategic water stewardship components and propose relevant strategies remain scarce. Moreover, despite the rapid advancement on various CPSs technologies, there is still a lack of empirical studies on how WSAs would be adopting these CPSs into their future strategies for the pursuit of better water stewardship.

1.2 Research Motivation

Water management and steward practices is without doubt vital to sustain life, support healthy environments and to grow the global economy (Orr & Sarni, 2015; Schlosser et al., 2014; UNESCO, 2012b). It is estimated that by 2050 more than 70% of the global population will be located within either a major town or city. It is

predicted that industrial and domestic water consumption in developing countries will grow faster (Cashman & Ashley, 2008) Therefore the efficiency of existing infrastructure and water uses will become a major consideration. Cashman and Ashley predict that increasing water losses in urban areas and small water infrastructure maintenance budgets will intensify the issues of water scarcity (2008).

These trends and issues will place an ever-increasing burden on governments and WSA alike. This begs the question as whether WSAs are prepared for the problems at hand, and whether they have the foresight to put solutions into place. This study will focus on foresight of leaders within the environment of WSAs to uncover their readiness in leading the way to enhance water stewardship practices. The findings of this study can serve as a guide for other WSAs in planning and implementation of water stewardship practices that will help mitigate the risk of future water scarcity.

This study will thus provide benefits to the economy mostly in context of risk management, as a major crisis in the water industry will negatively affect not only large companies, but the GDP as a whole. Since a pronounced lack in research in the perceptions of experts in the water field of South Africa is evident, a clear theoretical need for this study exists.

1.3 Research Scope

The study aims to investigate the future preparedness of selected WSAs as water resources are becoming scarcer. Schmidt (2009) found that strategic foresight is a lacking component in many government agencies. A few other aspects also need to be addressed in the pursuit of better water stewardship, including water resource sustainability and supply reliability. This includes taking a closer look at seasonal water levels in dams and rivers, and how to most effectively utilize this source. Supply reliability is of major importance, as a lot of water is wasted due to old and poor water infrastructure. Should leaking pipelines and spillages be allocated quicker, much less water will be wasted. Supply reliability also addresses equitable water resource sharing. Allowing water to be distributed evenly will empower all communities at an equal basis. Wastewater treatment is another vital aspect that will allow us to become a more water sustainable country. Recycling water will

reduce not only the amount of water that is lost, but will also reduce water pollution of other water sources.

Should WSA's have enough foresight to identify the above mentioned critical aspects and trends mentioned earlier, they might be able to see the value that CPS can add to water stewardship practices. ICT can provide WSAs with essential capabilities to analyse and review real-time data, monitoring water usage efficiencies and improving day to day management tasks. Dam and river levels can be monitored, water pressures and flow rates through pipelines can be recorded for early detection of faults and recycled waste water quality can be evaluated. Many more possible uses for CPS in water stewardship may be identified.

Parameters of this research study will include discovering perceptions of experts in the water industry around current factors that are influencing water stewardship in either a positive or a negative way. The study will also explore the factors that these experts deem important for the future of our country's water industry, and the role that they see ICT play in that future. The scope of individuals who will be interviewed will come from various working sectors in the WSA environment, including research institutions, non-governmental organisations (NGOs), water boards, the private sector consultant as well as the department of national government.

Kaleidoscope Five-S Future-Fitness Framework (Visser, 2015) will be utilised during the development of research question three that will be used during interviews. The framework for achieving a sustainable water balance by Rosa et al. (2013) will be used in the analysis of data. This will be linked to the definitions of water stewardship as set out by AWS. Lastly the Cynefin domains will be used to categorise final data sets into domains during the conclusion of this study.

1.4 Research Objectives

The main objectives of this research were:

Objective 1: to uncover the key components (current factors) identified by experts in the WSA environment that plays a role in their daily pursuit to harness effective water stewardship.

Objective 2: to explore the relevant components (future factors) that will play a role in improved future water stewardship practices, and that may transform water providers into world-class water stewards. The purpose of this objective is to probe the foresight of water professionals that will influence strategic planning and future policies

Objective 3: Identifying methods that ICT can complement the sustainable water balance frameworks to enhance water stewardship as well as the opportunities and challenges associated with ICT.

Obtaining answers these three objectives answered the question of whether experts in the WSA environment deem ICT a solution to better water stewardship practices. Their perceptions on the challenges in the implementation of ICT may pave the way to finding solutions for these problems.

CHAPTER 2: THEORY AND LITERATURE REVIEW

2.1 Introduction

The theory that is reviewed in this section defines and describes the concept of water stewardship, cyber physical systems and strategic foresight. The research problem that has been identified alludes to factors on the environmental, organisational and individual level that could affect enhancement of water stewardship.

This study is of an exploratory nature; hence the literature review presented here is a preliminary one and was subsequently directed by the findings of the interviews (Saunders, Lewis, & Thornhill, 2012; Saunders & Lewis, 2012).

2.2 Analysis of water scarcity

A number of world organisations such as the World-Wide Fund for Nature, World Business Council for Sustainable Development, International Union for conservation of Nature and International Food Policy Research Institute have estimated that the global population will grow from the current 6.9 billion people to about nine billion people in 2050 (Food and Agriculture Organization of the United Nations (FAO) and the World Water Council (WWC), 2015; Sanberg, 2010; UNESCO, 2012a). This will substantially increase demands for food, energy and water.

About a third of the global population already live in water scarce regions. Interestingly, this part of the global population was responsible for nearly a fifth of the world's GDP in 2000 (Schlosser et al., 2014; Veolia Water, 2011). Based on "business as usual," scenario projections show that the number of people that will be exposed to stressed water resource conditions in 2050 will grow to slightly more than half the global population while about a tenth of the population will live under severe water scarcity conditions (Orr & Sarni, 2015; Sanberg, 2010; UNESCO, 2012b). It is also estimated that about 50% of Global GDP will be heavily reliant on the level of water scarcity in 2050. This may well adversely affect many economies and business across the world. Given the expected environmental turbulence on global level we all need to improve our water stewardship practices in order to

achieve a sustainable future, especially as it threatens a basic human right (Gorchev & Ozolins, 2011; Hepworth, 2012; Orr & Sarni, 2015).

Generally, governments and WSAs have responsibility towards their citizens to ensure safe and reliable drinking water. This highlights that governments and WSAs need to look deeper into the current water issues in order to observe, understand and anticipate key drivers that shape strategies of the future. On the contrary (Schmidt, 2015) found that many organisations, including government agencies, face complex and uncertain futures due to lack of foresight.

“Foresight” as a term we have been used in studies to describe critical thinking concerning long-term developments and to explain the understanding of how unexpected events can very negatively affect an organization. It also helps to describe how the future might be shaped, especially by influencing public policy (Schmidt, 2015). Careful consideration into the foresight of our water pandemic is needed, not only on a global level, but also as each country to its own.

In South Africa the Department of Water and Sanitation (DWS) leads and regulates the water sector. They are governed by the National Water Act and the Water Services Act. The DWS is also responsible to develop national policies and strategies that will provide and enable an environment for effective water stewardship. The responsibility of day to day water management has been assigned to 152 WSA’s across South Africa. There are currently nine Water boards (WB’s), that forms part of the WSA’s, with the responsibility to supply bulk raw and potable water across vast distances to multiple users. The Government has planned to consolidate the existing WB into only six after 2020. Water use per economic sector in South Africa has been reported at 60% for agriculture, 27% for domestic, 3% for industrial, 4.3% for power generation, 3.3% for mining and 2.5% for livestock and nature conservation (Department of Water Affairs and Forestry (DWAF), 2013).

As Medema et al. states; the processes and dynamics involved in natural resource use is complex.(2008) states; the processes and dynamics involved in natural resource use is complex. Local literature and studies have highlighted a number of different issues in relation to water stewardship: the shortage of innovation as a

direct result of paradigms and theories of operandi (Meissner, 2016); weaknesses of institutional capacity, provisions to control abstraction and pollution, and a lack of cross sector policy coordination and implementation (Pietersen, Holland, & Adams, 2012); the need for a development of municipal conservation and demand management strategy and business plans (Wegelin & Jacobs, 2012); the lack of traditional governance and traditional leaders in water resource management (Kapfudzaruwa & Sowman, 2009). In addition to this, Ruiters (2013) diverges on backlogs of investments in water infrastructure. Massoud, Tarhini and Nasr (2009) In addition to this, Ruiters (2013) diverges on backlogs of investments in water infrastructure. Massoud, Tarhini and Nasr (2009) agrees with Ruiters on the topic, but suggests that developing countries needs to focus their attention on planning for low cost alternatives instead of big centralised water treatment plants.

Research by McKinsey & Company (Addams et al., 2009) show that by 2030 South Africa will have a 30% gap between supply and demand as result of anticipated climate change and circumstances. The impact of the supply gap will be evident in future trade-offs between water consumers such as agriculture, industries and domestic demand.

South Africa is classified as one of the driest countries in the world as its total water use of 17.3billion m³/annum exceeds the total reliable yield of 15billion m³/annum (Department of Water Affairs and Forestry (DWAF), 2013; Wegelin & Jacobs, 2012), therefore the necessity to study various mitigation measures that could possibly reduce future water shortages.

2.3 Relevance of water stewardship

Water stewardship has been in the spotlight at an increasing frequency during the last decade because of water resources that have come under threat of sustainability. Many areas around the globe have been exposed to water stress and scarcity (WWF, 2013) that will eventually manifest as integrated risks to communities, the environment and industry (Rozza et al., 2013). In today's connected age with growing consumer awareness, individuals and businesses are realising that the actual value of water is much greater than at its present cost. In

order for firms to be sustainable they have to look beyond corporate social responsibility and reflect on the shared risks (Orr & Sarni, 2015).

Rozza et al. (2013) states that the first step in setting up a business water stewardship strategy is to understand how the strategy feeds into the overall firm's strategy. Consequently, water-related risks have to be evaluated in order to define the impact of water stewardship strategies as means to mitigate such risks. Deloitte consulting (2012) supports this view in saying that:

“Water stewardship requires a sound understanding of water as a resource with strong connections to political-economic objectives, such as health, energy and agriculture. Only with this understanding can a company craft a strategy that is relevant to various stakeholders. However, even with an enlightened strategy, companies must be mindful that the rules of the game are set by government. Stewardship, therefore, requires policy advocacy quite unlike anything most companies have done before.”

Another definition that seeks to drive water stewardship is defined by the AWS Standard as the use of water in a way that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process (Imane et al., 2013). The AWS standard is based on a six steps evaluation process that is applied to any site that interacts with water regardless to types of water being dealt with. At the end it then categorises a firm's water stewardship performance into three incremental levels e.g. core, gold and platinum.

WWF (2013, p. 1) defines water stewardship as “a progression of increased improvement of water use and a reduction in the water-related impacts across the value chain.” Ideally a zero and sustainable balance is desired thus returning an equivalent volume and similar quality of water to nature as that which was used in the manufacturing processes and products.

Rozza et al. (2013) developed a corporate framework for achieving a sustainable water balance (Figure 1). Although the frame is focussed at enterprise level it is based on similar principals to that of the AWS Standard and will allow a means to analyse water stewardship practices based on five elements:

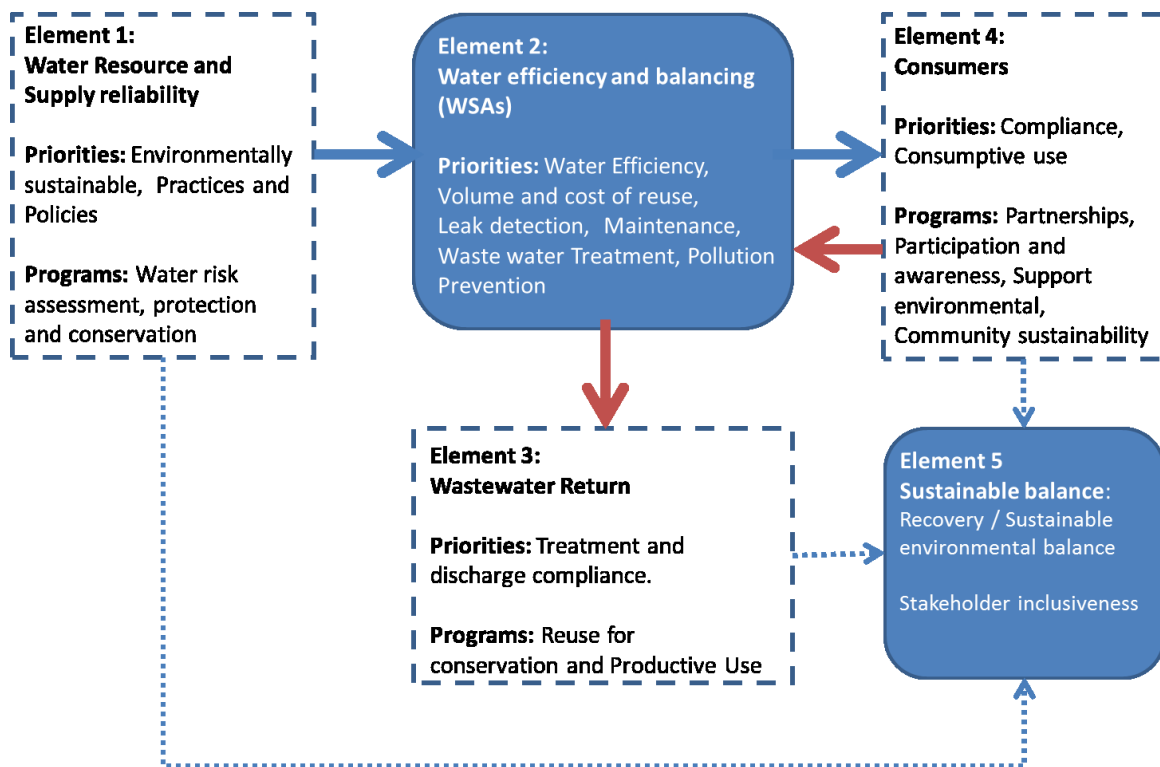
- Water resource sustainability and supply reliability

- Water efficiency and economics
- Wastewater Return
- Water Output and consumptive uses

Sustainable water balance

Figure 1 outlines the four main elements which were subsequently discussed. The first element was used to determine: if the water source is environmentally sustainable over time; to what extent were water resource management practices and policies applied; whether future infrastructure and funding policies are in place (Rozza et al., 2013). The second element (Rozza et al., 2013) was used to balance consumptive uses of water with factors of efficiency and cost of water use. Rozza et al. also considered the cost of water protection, future usage requirements and paid particular interest into prevention of consumption beyond the point of water source sustainability. Examples offered by Rozza et al. for improving efficiency included the support of leak detection and quick repair of distribution networks.

Figure 1. Framework for achieving a sustainable water balance.



Adapted from (Rozza et al., 2013, p. 43)

The third element includes factors of compliance with local regulations, reliable treatment system operation and confirmation that wastewater discharges are not adversely impacting local watersheds (Rozza et al., 2013). Regular waste water sampling and analyses is required to ensure compliance. In element four of the framework, Rozza et al. focussed on the relationship between the business and the local community, industries, research institutions, government authorities, NGOs, water associations and media awareness and reporting on water issues. A degree of collaboration and the company's participation within the surrounding communities are essential to better water stewardship. Other research studies also emphasised the importance of stakeholder involvement in the pursuit of integrated water resource management, including that of civil society (Dungumaro & Madulu, 2003), private partnerships (Pinheiro, Savoia & Angelo, 2016), and according to DWS also provincial government, municipalities, water boards, tertiary institutions, community organisations, NGO and the business sector. According to Rozza et al. the fourth element also addresses public education and awareness projects.

The last element shows the integrated nature of all the other factors, and discusses how water as a resource, operating efficiency, wastewater return and the consumers intersperses to obtain the best quantifiable and sustainable water balance. These relationships in essence may be the basis of effective water stewardship.

In principal, even though a water stewardship framework offers a way to evaluate one's own performance, there are still a number of intricacies water managers are required to resolve on a daily basis. Examples of day to day intricacies include: how to balance a firm's water demand and supply in real time, ensuring high recoveries and usage efficiencies, overseeing day to day operations, keeping in touch with surrounding communities in terms of water usage as well as the quality of effluent being discharge back into the environment amongst others.

Ideally, implementing strategies adopting CPSs will help solve some of these complexities by providing the firm with the essential capabilities: to analyse and review real-time data (e.g. volumes and flows), monitoring water usage efficiencies, help to improve day to day management tasks and provide an easy platform for networking and communication (Wang et al., 2015).

The implementation of CPS will lead to improved water stewardship practices and standards as is already evident in the case of smart metering technologies (Beal & Flynn, 2015). However, the adoption of smart metering technologies by water utilities has been slow in other countries due to large capital investments and unknown ROI's (Beal & Flynn, 2014). It is predicted that for similar reasons as in the case with smart metering, the implementation of CPS in water industries will be slow and poorly aligned with other corporate strategies, for example profit maximising.

To shed light on this important gap we formulated the following research question:

Research Question 1: What are the key components (current factors) identified by experts in the WSA environment that plays a role in their daily pursuit to harness effective water stewardship?

2.4 Foresight and strategies

Schmidt (2015) proposes that existing government and WSAs organizational frameworks consists out of three functional components: policy, planning and intelligence. Schmidt explains that policy includes principles that influence and determine decisions and protocols, planning is a process of determining future objectives and the strategies involved in achieving them and finally, intelligence looks backwards as well as at the current state of affairs in order to predict what lies ahead. It seeks detailed, fact-based answers to address specific questions (Schmidt, 2015).

Strategist alike Igor Ansoff, Peter Drucker, Kenneth Andrews, Henry Mintzberg, Stuart Hart, Richard Rumelt ,Gary Hamel and C.K. Prahalad all had one thing in common which is partly expressed by the words of Frederick Taylor "the one best way" (Mintzberg, 1994a). Taylor was implying that the most efficient way to conduct work is by carefully analysing it. This can allow a firm to become more efficient and resourceful at achieving its goals.

At corporate level three key principles are introduced with regards to strategic foresight: identification of the predetermined elements of the environment; the ability to be open minded to a set of alternatives and to develop a broad set of possible outcomes in the business environment before focussing on details (Chermack & Coons, 2015).

In order to produce effective decisions in today's highly complex environment, one needs to incorporate a component of strategic foresight into the organizational framework (Schmidt, 2015). Where policy, planning and intelligence looks at the organisation's primary decision making apparatus, foresight identifies and examines weak signals, plausible future and emerging trends. Schmidt explains that foresight considers the entire spectrum of possibilities on the horizon, and is consistent with effective risk management strategies. It also provides a background for predictive analysis and planning.

Schmidt (2015) found that a big lack of strategic foresight is seen in most countries in the world. He estimated that only approximately ten percent of sovereign countries have established on-going foresight functions. Reasons provided by Schmidt for this includes the endless succession of near-term emergencies which often diverts form the longer-term challenges that need to be shaped over a longer period of time. The system is unceasingly driven by very urgent short term emergencies. Schmidt raised the question as to how strategic coherence can be achieved in such a system.

In a search for the ideal most important factors that will play a role in future sustainability the research question below explored and assimilated the ideologies of many.

Research Question 2: What are the most important factors that will play a role in improved future water stewardship practices, and that may transform water providers into world-class water stewards?

The purpose of this objective is to probe the foresight of water professionals that will influence strategic planning and future policies.

2.5 Digital business strategies and Cyber-physical systems

Bharadwaj et al. (2013) termed digital business strategy (DBS) as the fusion between IT strategy and business strategy. The idea behind DBS is to rethink the way that IT strategy was aligned to business strategy in the past, the so called 'alignment view', to one where it is part of the overarching view of strategy. Drnevich and Cronson (2013) used a comprehensive framework to explain what integral role IT can play in a business. DBS provides a business with critical information. Using this information will allow a firm to be more efficient as well as make better decisions.

According to Bharadwaj et al. (2013) the scope of DBS should be viewed relative broadly as digital resources stretch beyond the firm's traditional boundaries in order to form dynamic ecosystems. It includes cloud computing, the internet of things (IoT), social platforms and networking amongst others, all of which provides higher availability, reliance and a dynamic capability to rapidly scale up or down its infrastructure. The scale of DBS also allows alliances and partnerships that will enable shared digital assets with other firms in the business ecosystem. The speed of DBS includes faster decision making, speed of supply chain orchestration and faster network formation and adaption. Sources of value creation embrace more efficient control, increased information from networks making it easy to democratization and share as well as multisided and coordinated business models (Bharadwaj et al., 2013).

Wang et al.(2015) envisioned the opportunities for an intelligently networked water cyber-physical system (CPS) that could aid water stewardship. He defines CPS as "intelligently networked systems with embedded sensors, processors, and actuators that are designed to sense and interact with the physical world and human users, and support real-time, guaranteed performance in safety-critical applications" (p. 2). To develop a water CPS, Wang et al. (2015) advices that the following components are required:

- Sensing, communication and networking technologies
- Computing technologies
- Adaptive and predictive hierarchical hybrid control technologies.

Over the last few years many advances were made in each of the above components. Wang et al. (2015) explained that a water CPS will enable monitoring of real-time water quality parameters. Moreover, it will detect and predict transport of pollutants in the water environment making it possible to react to emergencies faster. Bayoumi (2015) agreed that CPSs will help solve the great challenges of our society; challenges such as resources sustainability.

Bayoumi (2015) said that design challenges, like building a ICT frameworks between the cyber and physical environments are not a trivial task, since it requires new theories, models and algorithms. Another study concurred that existing computing and network abstractions will have to be rebuilt to allow the implementation of CPSs (Lee, 2008). In contrast to the above, Jazdi (2014) stated that many of these problems have been resolved with the implementation of Industry 4. At present, Industry 4 is characterised by features like smart networking, mobility, flexibility, integration of customers and new innovative business models. DBS, CPS and Industry 4 offer ICT solutions that will aid water stewardship by enhancing the knowledge and effectiveness of firms.

The Kaleidoscope Five-S Future fitness framework (Visser, 2015) has been set up to test individuals' perceptions around products. This framework consists out of five key criteria for determining whether the solution (or product) is future fit, namely: safe, smart, shared, sustainable and satisfying. A safe future is one in which the product doesn't damage our health and wellbeing. Products that are smart should make us more connected to allow sharing. A shared future considers aspects of equity and access. Futures that are sustainable reflect facets of renewable, enduring and evolutionary impacts on the ecosystem. The last criteria considers if the product is beneficial with respect to enabling a quality lifestyle.

This framework was used in the set-up of the third research question for ICT use in the water industry.

Research Question 3: How can ICT complement the sustainable water balance frameworks in order to enhance water stewardship and what are the opportunities and challenges associated with ICT?

2.6 Continuous Change Theory and Cynefin framework.

Having determined the importance of foresight, we need to consider the nature of it in practice. The world doesn't always work practically as in theory, thus the task of foresight is more complex. Wrong assumptions can be made according to facts that we think we know. Things, however, are not always what they seem. Some aspects of frameworks and established models remain valid despite circumstances, but we have to note that others do not (Wayland, 2015). Wayland suggest that this could jeopardise the criteria and authority of our work. For example in the market environment and company capabilities, we will do strategic planning based on our understanding of the market. This might prove downright dangerous in times of great uncertainty.

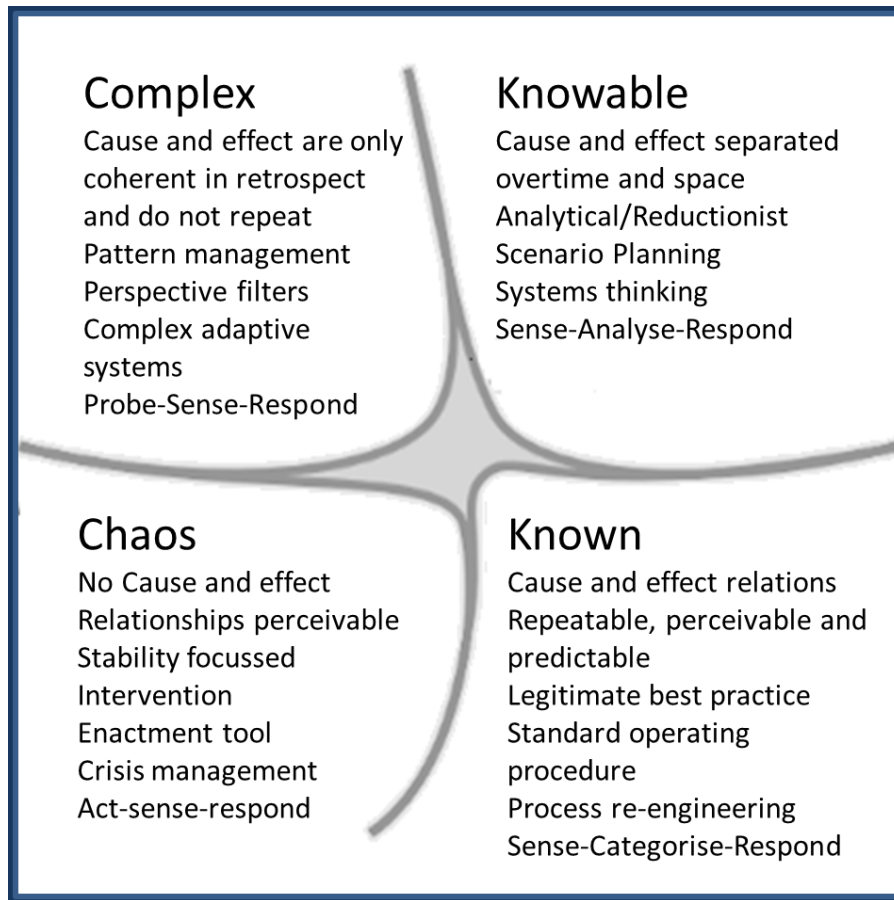
Environments do not stay the same, at the best of times they are evolving. This revolutionary change reflects a movement in the ontological boundaries that define a specific environment (Wayland, 2015). There are specific boundaries of "what we can know", but these boundaries can be extended using foresight. Yet, Wayland suggests that to completely embrace the nature of change, we must reflect on both its epistemological and its ontological boundaries.

It is thus important to take into consideration that change is inevitable. Another aspect that needs to be kept in mind is timing. Small changes in complex systems' initial state can alter long term behaviour significantly according to the complexity theory (Brown & Eisenhardt, 1997). Brown and Eisenhardt (1997) defines it as the study of complex and chaotic systems and how order, pattern, and structure can arise from them.

A model that takes both the viewpoints of Wayland and Brown & Eisenhardt into consideration is the Cynefin framework (Kurtz & Snowden, 2003). It is divided into domains, namely what is known, knowable, complex and chaos. There is also a fifth domain, namely the disorder domain, which is represented in the centre of the framework as indicated in Figure 2. Cynefin gives decision makers powerful new constructs that they can use to make sense of a wide range of unspecified

problems. Cynefin consists of the narrative and complexity theory that is often used in organizational knowledge exchange, decision-making, strategy and policy-making.

Figure 2. The Cynefin Framework



Source:(Kurtz & Snowden, 2003, p. 468)

Foresight cannot be seen as a linear construct, it is subject to the environment and the changes associated with it. A lot of the information that was gathered during this study fell into categories of the Cynefin framework that is not necessarily known. Information provided by participants fell into the “knowable”, “complex” or even “chaos” divisions. Assumptions were made with care. Cynifin also ties into foresight with regards to the organizational framework as was mentioned in the discussion on strategies and scenario planning (Kurtz & Snowden, 2003).

2.7 Conclusions of Literature Review.

In conclusion, it is clear from literature that water as a resource needs to be protected, managed and utilised wisely. Water stewardship includes all of these

aspects, and to enable effective water stewardship practices, foresight and planning plays an absolutely vital role. It has been said that planning is lacking in most institutions, and the premise is that the South African water services are not different. ICT might play an invaluable role in the transition of old school thinking and techniques into an era where communication, partnerships and data flow freely. It is important to identify the stakeholders that will be part and parcel of this process, including NGO's, civil society, private sector consultant, water boards, research institutions as well as government themselves.

CHAPTER 3: RESTATEMENT OF RESEARCH QUESTIONS

This study investigated how ICT could improve water stewardship practices. Many determinants were considered in the light of the broader environment and the organisation.

According to Daft (1983) significant studies have often approached the research problem as open ended questions to be answered and discovered rather than specific hypotheses to be proved. The open-ended questions that were answered during this study were:

Research Question 1: What are the current key components in the municipal water industry that currently plays a role in effective water stewardship?

Research Question 2: What are the most important future factors that will play a role in improved future water stewardship practices, and that may transform water providers into world-class water stewards?

Research Question 3: How can ICT complement the sustainable water balance frameworks in order to enhance water stewardship and what are the opportunities and challenges associated with ICT?

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Research Method

4.1.1 Rationale for method

Zikmund (2003) stated that there are three purposes for exploratory studies: diagnosing a situation, screening alternatives and discovering new ideas.

In a certain sense, all three purposes for exploratory studies were applicable to this study, as this study considered diagnosing the current level water stewardship and foresight by water professionals, the identification of possible solutions for the problems identified, and the building of a conceptual framework that could be helpful in future endeavours.

As in the iceberg principle, typically only ten percent of information can be seen above the surface, whilst ninety percent remains unseen (Zikmund, 2003). It was anticipated that in this study the same problem would be faced, thus questions in the questionnaire were focused to direct the participant's focus to deeper levels. A philosophy of interpretivism was necessary to differentiate between subjective details, meanings and realities of the respective outcomes (Saunders et al., 2012).

A methodological choice of mono method qualitative semi-structured interviews was used to achieve a deeper understanding of the determinants at play within the selected environment. The end results was purely descriptive of what was uncovered; hence there was no intention to seek any causal relationship between variables (Saunders et al 2012).

Benefits of the utilised research method lent itself to flexibility and adaptability in the uncovering of important variables (Saunders et al., 2012). Although a fixed questionnaire was developed, it did allow for additional probing questions to enhance specific answers of respondents, and to permit for a deeper line of thinking.

Difficulties like ambiguity and subjectivity are normally related to qualitative research methods. Processes of data analysis are also more time consuming than quantitative research tends to be.

4.1.2 Research Process

The research project took on the form of a qualitative research approach consisting of semi-structured interviews with water professionals and experts in the WSA environment. To ensure the relevance of the professionals' opinions, the following selection criteria was applied:

- A tertiary qualification
- Has at least three years' experience in the water service industry at a management level.

The aim of the research questionnaire was to determine the views of water professionals and water experts regarding the strategic foresight and implementation of ICT and the effect it may have on water stewardship practices. In addition, interviews explored the elements that are necessary to help lay the foundation for ICT adoption, which may enhance water stewardship effectiveness.

Several research questions were developed per the Kaleidoscope five-S future fitness framework to target more specific areas of this foundation (Visser, 2015). These questions were more specific in nature, but were asked if the participant's response to primary question allowed it.

4.2 Population and Unit of Analysis

4.2.1 Population

The population pool consisted out of various working sectors within the water service authority (WSA) environment. Working sectors within this environment that was interviewed included NGO's, research institutions, water boards, the private sector and government.

For the purposes of this study, the meanings of these working environments had to be defined. NGO's were considered as any non-governmental organisation which was organised on either national or international level that carry out various services, including humanitarian services, and advocates political participation through the provision of information. Research institutions included the council for scientific and industrial research and the water research commission. Water boards was counted as entities that is responsible for the supply and bulk distribution of

water. The private sector was defined as consultants within the water industry and lastly, government, also known as DWS, was regarded as the national department dealing with water and sanitation related matters.

4.2.2 Unit of analysis

The unit of analysis was the environment of WSAs. Analyses focussed on the collection of data based on the knowledge and experience of professionals in the various working environments under the umbrella of WSA (Zikmund, 2003). The key variables that were studied included factors around water stewardship, ICT and the level of displayed foresight of the various working environments.

4.3 Size and Nature of the Sample

The sampling method was a combination of non-probability techniques, including purposive and snowball sampling. Saunders and Lewis (2012) recommends using purposive sampling particularly when selecting small samples of qualitative data. This allowed for an active choice in the respondents who were interviewed based on qualifications, experience and exposure. Respondents could thus be chosen based on the assumption that they would be best suited and able to deliver valuable opinions around water stewardship. The first interviews were set up per non-probability techniques.

Snowball sampling was subsequently implemented to help identify successive members of the population that was difficult to identify at first. Respondents from the first interviews were asked to identify potential respondents who would suite the inclusion criteria and need of this study. This increased the possibility of locating potential participants that was best suited to help answer the research questions. Throughout this process it was kept in mind that snowball sampling might lead to a homogeneous sample, as individuals often identify others who are like themselves. Some of the population thus had a chance to be chosen by the researcher while others did not. Saunders and Lewis (2012) recommends a sample size of ten to 15 in the case of homogeneous populations. Semi-structured interviews were conducted with eleven respondents.

4.4 Data Collection, Data Analysis and Data Management

Although qualitative data is characterised by their richness and fullness, it usually requires more effort to interpret and analyse. Non-standardised methods typically yield large volumes of complex data that requires exploration, analysis, synthesis and transformation in order to address the research objectives (Saunders et al., 2012).

It is thus critical that one should analyse data as it is collected to develop a conceptual framework to guide subsequent work. This is also referred to as a grounded approach (Saunders et al., 2012). Data for this study was managed according to guidelines set out by Leedy (2001), which included the following steps:

- The first interview was conducted.
- The interview was recorded with a digital voice recorder (Bell office digital voice recorder).
- Data from the voice recorder was subsequently transcribed by a professional transcriptionist.
- Reflection was done on respondents' emotional state (including their body language and language used).
- Notes from the transcriptionist was then used in developing thematic categories using the words that respondent used.
- A word map was created using Atlas qualitative data analysis software.
- An overall sense of the data was developed, as meanings in the data started to become apparent.
- The above steps were repeated until "theoretical saturation" was reached.
- Finally, data was arranged into tables

4.4.1 Data Collection

Semi-structured interviews have been proven to be useful in cases of uncertainty with regards to potential answers that might be provided by respondents, as well as cases where questions appear to be complicated (Saunders et al., 2012). Data collection was non-standardised, and although all main questions were always

asked, this methodology provided flexibility to omit or add some probing questions as was found appropriate (Saunders et al., 2012).

Face to face interviews was the primary method of interview conduction, with only one case that necessitated the use of a teleconference. Face to face was the method of choice since alternative techniques may prohibit the interpreting of body language and conveying of trust.

Interviews was continued until theoretical saturation is reached (Morse, 1995), this occurred when additional data ceased to provide any new insights into the research question and objectives. Morse (2015) described saturation as the “..building of rich data within the process of inquiry, by attending to scope and replication, hence, in turn, building the theoretical aspects of inquiry” (p. 587). Essentially, it is not the saturations of new ideas or events, but rather reaching saturation in the characteristics within categories. In this study’s case, interviews were continued until a degree of convergence was found after interview 11 was conducted.

4.4.2 Data Analysis

The method of analysis consisted of a combination of narrative analysis, constantly comparing, and content analysis. Table 1 provides a summary of the data analysis that was used during this study. Data was analysed as per five generic steps set out by Saunders et al. (2012). These steps included:

- identifying categories;
- attaching data from disparate sources to appropriate categories;
- developing analytical categories further to identify relationships and patterns;
- developing testable propositions;
- drawing and verifying conclusions.

To assist with the identification of categories, a structured and systematic approach was followed by applying a method of grounded theory. This method is underpinned by the process of constantly comparing the data collected with the categories and

concepts being used (Saunders et al., 2012, p. 600). It also seeks to identify new ideas and theories.

Table 1 Data analysis methods for research study

Analysis Method	Rationale
Narrative Enquiry (Saunders et al., 2012)	This method preserves the continuity of the narrator’s account and optimises the analytical potential of this strategy. It usually encourages the narrator to give more meaning and interpretation of the events that will provide thick descriptions of contextual detail.
Constantly Comparing (Saunders et al., 2012)	This method is applied throughout the data analysis process. Data being collected is constantly being compared to the categories and concepts being used. This will aid the process of developing emerging theories.
Content Analysis (Zikmund, 2003)	This method focus on analysing the content itself normally in parallel with the above mentioned methods. It involves systematic analysis and observations to identify the specifics and characteristics of the content. It seeks to obtain a quantitative description of the manifest content of communication e.g. frequency analysis of certain words.

4.5 Data Validity and Reliability

Qualitative research may be subject to several reliability issues during the process. Some of these may include participant error and bias, the emotional state of the participant, the discretion of the interviewer as well as interpreter bias. Each of these factors is briefly discussed:

- Participant error and bias: the respondent might have been sensitive to time and the interviewing environment. This issue was likely in especially state-funded organisations. Requesting a meeting room or place outside participants’ immediate environment helped minimise bias.
- Participant emotional state: Circumstances may have impacted the emotional state of respondents. Aspects like stressful working conditions, physical health and relational matters amongst others could have had major impact

on answers provided. Cognisance of this fact was made and any discomfort and emotional signs were noted.

- Discretion of the interviewer: to a degree, the success of the interviews was dependent on the ability of the interviewer to ask the right questions at the right time. Thorough preparation minimised the risk of not gaining all possible information from a respondent. Additional preparation techniques included following a semi-structured interview, and gathering sufficient background information of the organization.
- Interpreter bias: The researcher is a professional in the water industry, so precautions had to be set-up to prevent personal ideas and opinions to be reflected upon respondents. An interview guideline was followed while a recording of the questions and answers were made. Transcribing was outsourced to a third party to help mitigate risk in the transcribing of responses.

Various ways of determining the validity of qualitative analyses of a study have been identified; like member checking, triangulation, peer reviews and external audits (Creswell & Miller, 2000). Creswell and Miller suggests that the selection of validity procedures should be carefully made, since the researcher plays a major role in the validity of a study.

In this instance, triangulation was used to find convergence between multiple sources of information so that categories could be formed (Creswell & Miller, 2000). Categories for this study was generated firstly from information gathered during interviews with respondents. Secondly, categories were formed taking into consideration frameworks and theories from literature and lastly, from insights, observation and interpretation of methods. The latter aspect entails the assumption, beliefs and biases of the researchers and is also known as reflexivity (May & Perry, 2011).

Examples of coding are supplied in Appendix 4.

4.6 Potential Research Limitations

Since only a few respondents in the WSA environment were selected the outcomes of study is not representative of the entire population and therefore the ability to generalise the results are limited. Limitations also include non-response bias created with the choice of the population and the selection criteria, for example if a new or junior professional who has insight into the topic is not interviewed. Some other limitations to this methodology might include:

- The researcher's bias and reflexivity as well as his role in the environment could have influenced the study.
- Though the study acknowledges global trends, it is limited to the South African environment and context.
- Though every effort during the questionnaire and piloting was made to limit the impact and biases in language, the interviewer is not expertly trained in interviewing and this could have had an impact on the results.
- The sample selected consisted of managers, professionals and experts in the environment of WSA. Even though many respondents have frequent contact with local WSA's, the study did not include managers at local municipality levels.
- Geographical bias: Though a broad range of stakeholders were engaged, most respondents were located close to Johannesburg, Gauteng, South Africa. Therefore, a geographical bias and limitation might be present.

According to Zikmund (2003), other limitations that exist for in-depth interviews and respondents include:

- Duration of interviews is limited: To achieve enough depth during an interview longer interview durations are required. Respondents might not have been able to express all opinions and evidence during the limited duration of the meeting.

- Emotional limitation: If the respondent was pre-occupied with other thoughts their answers was often short and superficial.

CHAPTER 5: RESULTS

5.1 Introduction

Valuable insight into the factors that are currently at play within the South African WSA environment were obtained through the interviews that were conducted as part of this research project. The study highlighted which factors are important in the pursuit of sustainability water stewardship practices. It also places the focus on the opportunities and challenges of implementing ICT in aid of this quest.

A summary of the interviews that were conducted is provided in the beginning of this chapter, together with the methodology utilised in conducting the interviews. The transcription coding and analysis is then discussed to ensure the accuracy and validity of this process. The respondents that partook in the interviews are discussed, and then each research question of this study is extrapolated on in detail.

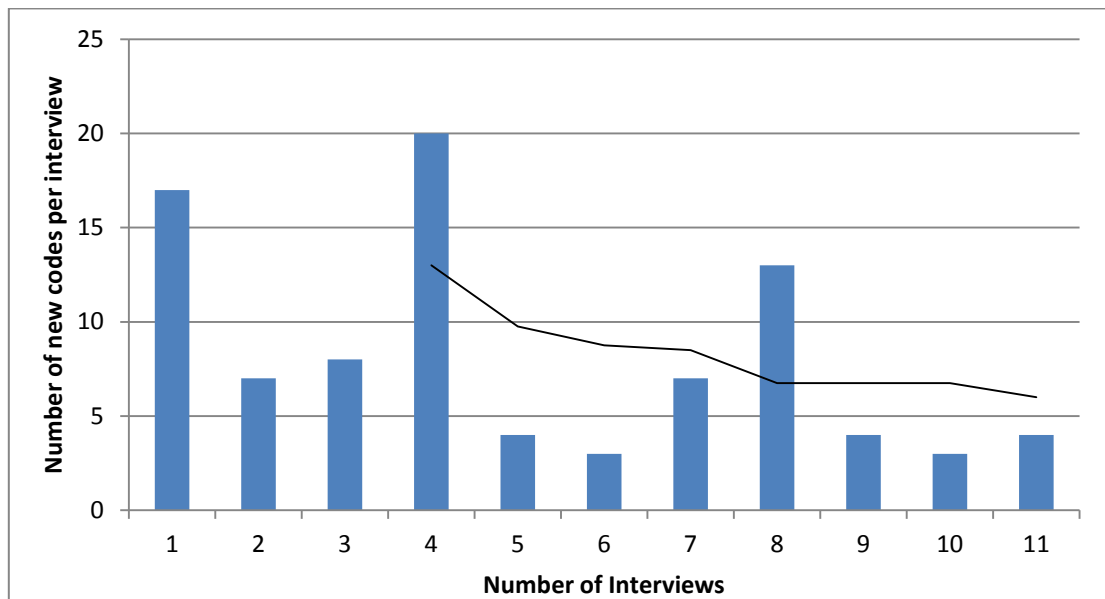
5.2 Description of sample and data sorting method

5.2.1 Summary of interviews conducted and the interview method

Interviews were conducted inductively until a point of data saturation was reached (Morse, 1995, 2015). As displayed in Figure 3, a data saturation curve was drawn following the ninth interview to indicate the amount of data captured up to that point. The rolling average of four respondents was used to determine whether any further interviews were required. There were two reasons for selecting a rolling average of four respondents. Firstly, around the fourth interview about 50% of the codes were already created. Secondly, this point is a good starting point to avoid high fluctuation around the mean.

After the ninth interview the curve flattened out around an average of seven new codes per additional interview; slightly higher than half the amount of codes for the initial four interviews. Based on this result, the interviewer conducted further interviews until the rolling average resulted in six or less new codes per interview in comparison to the initial four interviews. This would indicate that the rolling average is on a strong downward trend. A total of 11 interviews were conducted before this target was reached.

Figure 3. Data saturation



The last two interviews added a total of seven new codes compared to the existing 83 codes already logged. In addition it can be noted that the last three interviews resulted in the addition of an average of three to four codes, indicating data saturation.

Information regarding the respondents who were interviewed are summarised Table 2 in chronological order. Hence forth each respondent will only be identified by the manufactured credentials to honour their confidentiality.

Table 2. Respondent information

Resp.	Position	Job environment	Operations	Length [hh:mm:ss]	Word Count
1	Bulk Operation Manager	Water Board 1	X	01:33:00	11654
2	Senior Researcher	NGO 1 - Planning and Networks		01:16:00	10131
3	Research Manager Potable water and ICT	National Research Institution 1		01:25:41	8082

Resp.	Position	Job environment	Operations	Length [hh:mm:ss]	Word Count
4	Maintenance Manager	Water Board 2	X	01:18:04	9323
5	Water Expert	Private Sector 1	X	01:37:58	11656
6	International Water Stewardship Advisor	NGO 2		01:16:42	9717
7	Technologist: Water Governance & Planning	Private Sector 2		01:09:14	7552
8	Operation Specialist	Water Board 2	X	01:47:57	9810
9	Principal Researcher: ICT in Potable water	National Research Institution 2		01:24:41	15116
10	Head Technical Services	Water Board 3	X	00:24:42	2972
11	Chief Director	National Department 1		01:12:42	9611
AVERAGE:				01:18:47	9602
TOTAL				14:26:41	105624

Local WB's provided candidates for four of the interviews. In order to cover the broader WSA environment, interviews were also conducted with two senior researchers, each from a different national research institution. Two consultants from the private sector that works in water governance and planning were also included in the interview process. Lastly, two advisors from NGO's within the water industry that works with local programmes, partnerships and country networks as well as one director from DWS were included. This allowed for inclusion of views from most major water role-player, granting validity to this study.

A total of 866 minutes (over 14 hours) of audio were recorded during the interviews, and transcribed by a professional transcriptionist. The total word count from all transcripts amounted to more than 105 624 words. The average interview was 78minutes long while the average transcript length was just short of 10 000

words. This interview duration allowed the respondents to go into depth about their perspective on each of the three key research themes.

Prior to the onset of the interviews, a set of pilot interviews were conducted over a period of two months with four experts in the field of water. Based on these research questions, their understanding and advice, a questionnaire was developed as discussion guideline for the future interviews. The developed questionnaire has been appended.

With the exception of one telephonic interview, all of the interviews were conducted in person and in either a private meeting room or at a restaurant when preferred by the respondent. A digital voice recorder was used to record all meetings. The recording was then downloaded and saved after each meeting. Notes were also taken during the interviews to act as reminder of important points as well as to refer to items of interest for further discussion. Consent form require

Out of the 11 respondents, only one was known to the researcher prior to the interviews. A list of nearly 25 potential respondents was made by actively searching the internet, asking numerous business and development managers for referrals, attending and scouting at the WISA conference 2016 for potential candidates as well as following a snow ball technique asking for referrals at the end of each interview. Numerous calls and follow-up emails requesting participation were made after which 16 participants were short listed. A background check was conducted to ensure that potential participants met the study's selection criteria. Although many qualified and indicated a willingness to participate, their schedules would often time not allow to be interviewed. The researcher continuously aimed to obtain a broad view from the environment of WSA within the municipal sector and therefore strategically selected a balanced group of respondent as mentioned earlier.

At the start of each interview a set of general questions were asked and discussed to put the interviewee at ease and also to convey sense of trust with the interviewer. Thereafter the respondents spoke freely with regards to their personal views on each of the research questions. The respondents were surprisingly open and truthful with respect to issues and problems even pertaining to their own organisations. It gave the impression that all respondents were altruistic in nature.

In the case of the respondent that was interviewed telephonically while he was driving (with a hands-free-set), some questions were strategically eliminated to allow for a shorter discussion length and ensure the comfort of the respondent. Much care was taken to ensure that the core of each research question was still being addressed. The researcher asked shorter and more prompting questions rather than longer ones.

5.2.2 Interview transcriptions and verification

The first four interviews were divided into two batches and sent to two different transcription service companies. Upon return the accuracy of each respective transcription was verified by the researcher against the original recordings. Spelling mistakes and inaudible remarks were corrected based on notes as far possible. Thereafter one transcription Service Company was selected based on their accuracy and professionalism. All remaining recordings were transcribed by this company as it became available. As an additional measure of verification, the researcher also listened to the each of the recordings while analysing each transcript.

5.2.3 Transcription coding in ATLAS.ti

After collection of data, ATLAS.ti version seven was used for facilitating the analyses. ATLAS.ti has been acknowledged by many studies as an essential computer assisted tool that helps facilitate qualitative analyses (Rambaree, 2012). The tool allows researchers to think about a project, make preliminary reflection on ideas and create memos while constructing the research process. Friese (2014) proposed that the computer assisted approach be summarised into three principles namely; Noticing, Collecting and Thinking (NCT). This approach, however, does not consider various other methodologies of quantitative data analysis such as thematic analysis, narrative analysis and discourse analysis. Friese has been integral to the layout and design of ATLAS.ti, hence her NCT approach will be used as it seem to follow an grounded theory inductive analysis.

Following the recommendation from Friese (2014), all transcripts were converted to a rich text format (RTF) and every paragraph was identified at the start as either the RESPONDENT or INTERVIEWER. Between paragraphs a hard return (single line spacing) was inserted to allow certain ATLAS.ti auto functions. The transcripts were then loaded into ATLAS.ti as primary documents (PD's) and named sequentially with

the job environment and job title of each respondent. All names of respondents were excluded as part of the confidentiality agreement with each respondent. The data was predominantly coded inductively using the program's open coding, code by list and auto coding functions. The coding convention as recommended by Friese (2013, 2015) was followed, and is briefly explained in the Table 3.

Table 3. Coding convention

Prefix	Description	Examples
Numpad "#" (Attribute codes)	All paragraphs or answers made by the respondents were 'auto-coded' in ATLAS.ti with a '#' prefix to indicate that it is an attribute code. Attribute codes are used sort the data as well as to make comparisons.	#Gender:Female #RES07:NK" #Grouptype:Non-operational" #Jobenvironment:NGO"
"XX":_CATEGORY (Main category)	Category code prefix and name is normally used to save a quote that fits to a particular theme.	"CF:_CURRENTFACTOR" "MF:_MACROFACTOR" "FF:_FUTUREFACTOR" "ICT:_INFORMATION AND COMMUNICATIONTECH"
XX:"Codename" (sub code of XX:_CATEGORY)	Once multiple related quotes are available within a category a sub code is allocated to codes with similar topics.	"CF:Equity" "CF:Datacollection&Interpretation"
Astrisk"*"	ATLAS.ti 'Supercodes'. These codes are usually user generated queries that is a combination of codes.	*CF:Planning&Strategy&#Rating: POS

After the first nine transcripts were analysed, cumulatively all codes amounted to 620 codes. Source triangulation analyses (Creswell & Miller, 2000) were conducted to merged codes of similar meaning into one resulting target code. The target code

replaced the merged codes and “inherited” all of their references. Where a code with multiple quotations had to be merged into a the target code, the researcher worked through each quote using the object crawler function in ATLAS.ti and verified that the target code will suite the new code that was being merged. If the codes and quotations could not be merged in order to maintain the authenticity of the coded value, a new code was created. The clean-up procedure resulted in only 120 codes remaining. As part of the procedure all primary documents were revisited, verified and amended where deemed necessary.

The code table was also reviewed a number of times to ensure that authenticity of codes was not lost. The ATLAS.ti object crawler was used throughout the research analysis to search phrases that linked codes and quotes with each other. All occurrences were checked and recoded where applicable. This was also an attempt to remove any confirmation bias in the data. Before any final research analyses were conducted, the researcher also used the code analyser function to remove redundant codes. A redundant code usually occurs when two exact same codes overlap or the one is enclosed within the other. This program allows combining the codes through either revising the quotation size or by enclosing the smaller selection within the larger selection.

The final list of codes that were used is documented in Appendix 4.

5.2.4 Details of Respondents interviewed

Although a question about the respondent’s duration in their current position and responsibilities were asked with the intent to gain insight into their working age and qualification level, the researcher only later realised that incomplete information was obtained. In order to complete the information, the respondent’s LinkedIn profiles were consulted to include the missing data. The contextual information gathered through the interviews and LinkedIn is presented in Table 4.

Table 4. Respondent qaulifications and experience

Resp	Position	Education level	Experience [years]	Interview	LinkedIn
------	----------	-----------------	--------------------	-----------	----------



Resp	Position	Education level	Experience [years]	Interview	LinkedIn
1	Bulk Operation Manager	B.Tech (Water), BSc Hons	20-25		X
2	Senior Researcher	MSc Enviromental Sc, BSc Town and Regional Planning	15-20	X	X
3	Research Manager Potable water and ICT	PhD Chemical Technology, MSc Biochemistry, BSc	3-5	X	X
4	Maintenance Manager	Diplom Mech Eng	20-25	X	X
5	Water Expert	BSc Hons Chem	25-30	X	
6	International Water Stewardship Advisor	PhD Political Sc, MSc Enviromental Sc, Diplom Env Sc	15-20		X
7	Technologist: Water Governance & Planning	MBA, MSc water resource management, B.Eng. Civil	5-10		X
8	Operation Specialist	B.Tech (Water),BSc hounors	5-10		X
9	Principal Researcher: ICT in Potable water	PhD Computer Engineer	3-5	X	X
10	Head Technical Services	BSc Hons	25-30	X	X
11	Chief Director	B. A. (Psychology), Edu Diploma (UED). MBA @ MANCOSA	5-10	X	X

Only two respondents had an experience level of below five years but still complied with the minimum selection criteria of three years working period. Both of these mentioned respondents held a PhD in either Chemical technology or Computer engineering. Three respondents had more than five years but less than 10 years of experience, whilst the last six respondents all had more than 15 years of experience within the water industry. All participants held at least one tertiary education qualification. The highest education levels of the respondents included three with PhD's (Doctorates), two with MSc's (Masters), four with BSc's (Hons) or the equivalent thereof and two that either had a diploma or a BA degree.

5.3 Transcript Analysis through word counts

In ATLAS.ti the word count function, called the Word Cruncher, provided the researcher with a means to get an early idea of the range and salience of words used. The most frequently used words is usually the words of non-interest e.g, 'and', 'a' and 'the'. The program allows the user to use a 'stop list' to eliminate the mentioned words as well as any punctuation characters (like '?',',', etc.) from the word count list. Initially a full word count was conducted across all PD's to estimate the entire range prior to creating a stop list of unwanted words. The first word count delivered 6164 different words. The words were sorted from most frequent to least frequent. A new column was created and filled out with a '1' if the word was to be ignored in future counts. Some nebulous words were also removed during this process of elimination, for example 'less', 'more', 'much' and 'bigger'. The "stoplist" column was then filtered and copied into the ATLAS.ti stop list.

The resulting word count after elimination of the unwanted words focused only on the most frequent 150 words of interest. In comparison, the highest and lowest frequency on the list was respectively a 1040 and 10. A filter was applied in excel to provide the top ten most frequent words that were used during the interview process. Although these words were the most frequently expressed during discussions, the possible meanings for some words may have complicated assumptions.

As part of good data interpretation practices a confirmation check on the top ten words revealed that ATLAS.ti couldn't differentiate between the researcher's questions and the respondent's answers when running the Word Cruncher. The top ten list was then subsequently hard coded with the ATLAS.ti Query tool to understand the extent to which it was being influenced by the words in the researcher's questions. The outcome of the tool yielded values of between 5% (e.g. the word 'government') to 70% (e.g. the word 'time') of the total word count. For this reason, the researcher created a new Hermeneutic Unit (HU) within the programme and removed the researcher's questions before rerunning the results. This was done to obtain the unique reflections of the respective respondents for comparison and subsequent analysis.

Given the new screened and filtered list, all words that were either used as a different tense, singular or plural were then grouped under a single word for example {plan ; plans; planning} were grouped under {plan}, likely {manage; manager; management} were grouped under {manage}.

Table 5 lists the top 20 most common words that occurred across all transcripts, ordered by frequency. All words that consists of separate similar words that were grouped together are marked with an asterisk suffix (*). Appendix 5 provides the top ten words (as highlighted) per respondent to show the differences.

Table 5. Top 20 most common words

Overall Word	Count	Overall Words	Count
WATER	1040	INFRASTRUCUTRE	85
PEOPLE	229	DATA	74
MUNICIPALITY*	139	INFORMATION	71
PLAN*	135	MONEY	67
ICT	125	DEPARTMENT	62
MANAGE*	121	COUNTRY*	60
GOVERNMENT	118	RESEARCH	59
SYSTEM*	115	SERVICE	57
TECHNOLOGY	105	ACCESS	55
PLANT*	85	MAINTENANCE	50

Overall the word “water” was used the most during the interviews. This is congruent with the focus and the environment of this research study. The word ‘water’ was not used per-se as a category to code the quotes, since the word has a very broad application. Some codes do include the word water for example {Waterboards, Waterstewardship, WaterSystems; CF: Drought&WaterScarce}. An ATLAS.ti co-occurrence table was used to find the frequencies of co-occurrence of the word water in comparison to all the other codes. The results, as expected, were

distributed over all the codes and themes. A second analysis was conducted instead with only the attribute codes to see if anything interesting would be revealed. The selected attributes that were linked to the word 'water' are shown in the table below.

Table 6: Attributes co-occurring with the word "water"

Attributes	Co-occurrence frequency
#Gender:Female	509
#Gender:Male	559
#Grouptype:Non-operation	678
#Grouptype:Operation	387
#Interviewer	398
#Jobenvironment:NationalDepartment	81
#Jobenvironment:NGO	257
#Jobenvironment:PrivateCompany	103
#Jobenvironment:ResearchInstitute	295
#Jobenvironment:WaterBoards	329
#Rating:Bad/Negative/Difficult/Excluded/Expensive	133
#Rating:Good/Positive/Easy/Included	63

Table 6 could tell many stories, however, one of the most striking must be the disparity between positive and negative rating attribute. The perception of 'negative' ratings seems to far outweigh those on the 'positive' end. The reasons for such great differences will be explored further later in the report. Even though water boards (consisting out of four respondents) had the highest frequency for using the word 'water', accumulatively the non-operational respondents (six out of the eleven) outweighed the operational respondents almost by 1.5:1 when using the word water. Therefore, it could be said that on average the non-operational respondents

seemed to have used the word 'water' about 50% more frequently during discussions.

The word 'people' had the second highest word count. The highest five co-occurring codes with the word 'people' are listed in Table 7. The codes are indicative that the respondents comprehend the importance of public awareness, they are familiar with general perceptions around water, understands the issues with human resources and acknowledges the role that people would play in the opportunities and challenges of the advancement of ICT within the water sector.

Table 7: Highest frequency of codes co-occurring with the word "people".

Co-occurring Code	Co-occurrence frequency
CF:PublicParticipationAwareness	29
ICT:Opportunities	27
CF:Perception&HumanBehaviour	20
CF:HumanResources	15
ICT:Challenges	13

In conclusion, the word count allowed insight into the general thinking of not only different individuals, but also the diverse groups of role players. Identifying these words might prove valuable in finding common ground between these players to allow for a cohesive future plan within the greater water industry.

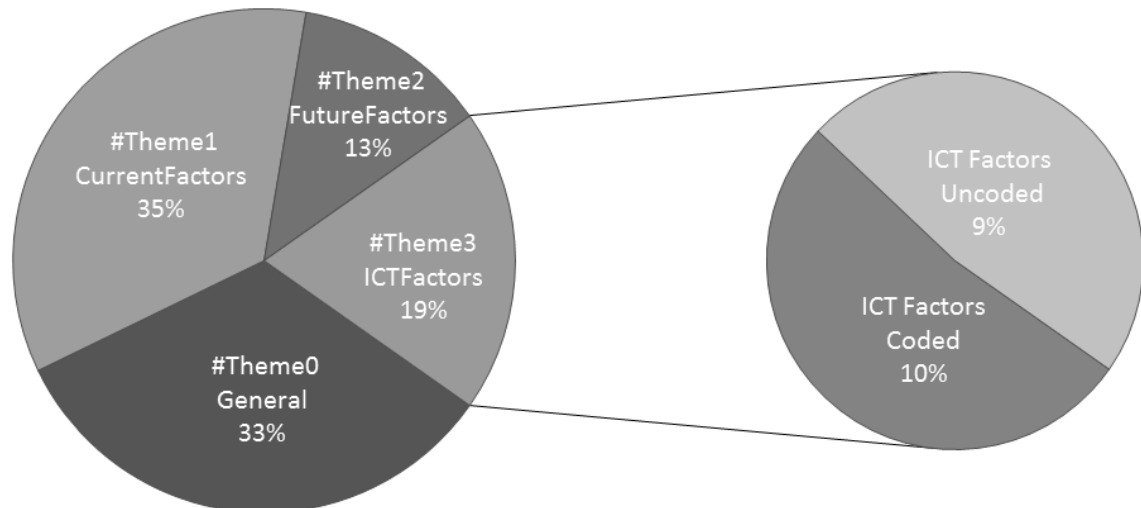
5.4 Transcript Thematic Analysis

A summary and definitions of ATLAS.ti terms that are used during the explanations are provided in Appendix 3.

An overall 'share of voice' chart is presented in Figure 4 to illustrate the amount of overall time that was expended on each of the respective themes. The last theme was broken down into the amount of overall time that had high relevance to the topic of discussion (e.g. coded) and the amount of time that was less related to the

topic (e.g. non-coded). This indicates that when the 'share of voice' analysis was used on a specific theme, it only compared it to the overall time that was relevant to that specific topic (e.g. coded).

Figure 4: Overall 'share of voice' chart



5.5 Research Question 1

A detailed questionnaire as was used during the interview process is provided in Appendix 1. The first research question was defined as follows:

What are the current key components in the municipal water industry that currently plays a role in effective water stewardship?

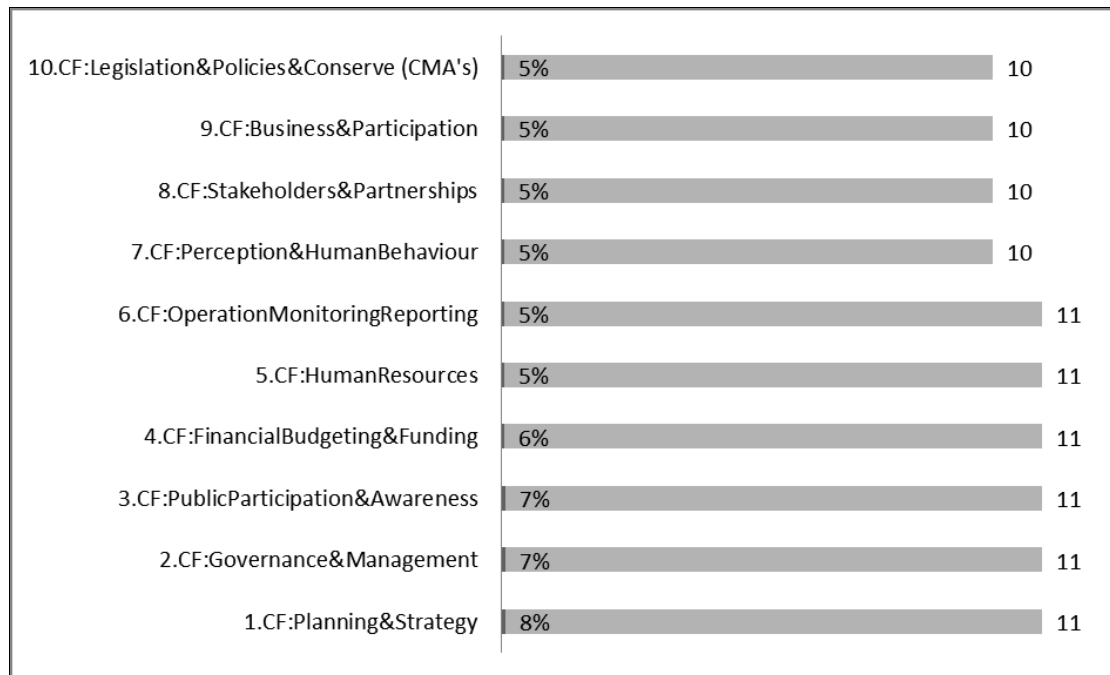
Results are discussed in two subdivisions, with the first section examining current factors identified by the WSA environment and the second section focussing on specific current factors identified by the smaller work environments within the WSA environment. Even though only the top ten current factors are identified here, a comprehensive list of current factors are presented in Appendix 7. This acts as measure of consistency to illustrate dependability of results.

5.5.1 Results for Research Question 1

Figure 5 illustrates the top ten out of 30 identified current factors identified from interviews from the entire sample population. All of these current factors were mentioned by at least ten of the 11 respondents, and accounted for almost 60% of

the time spent talking about current factors. The primary rankings of these factors were organised according to the amount of respondents who mentioned the current factor, and secondarily the percentage of time spent on the particular factor.

Figure 5: Top ten identified current factors that play a role in current water stewardship practices.



It is noteworthy that the most prevalent factor that was identified by the WSAs was planning and strategy. This demonstrates a common annoyance with regards to the current state of planning in the water sector. Governance and management follows closely, with public participation and awareness almost scoring the same. The top three current factors are congruent with the top ten words that was identified, linking with “plan”, “manage” and “people”.

5.5.1.1 Planning and Strategies

All 11 respondents identified that planning and strategy is critical in achieving enhanced water stewardship practices. Table 8 lists comments that corresponds to good planning and strategy procedures. Respondent 8 talked about typical planning horizon on department and municipal levels, while respondent 10 stated that holistically the country has got very good legislation and planning in place. Respondent 2 divulges on planning as stated that although there are plans in place, the countries’ national development plans are usually consumptive in nature. This

highlights the dichotomy between conservation on the one hand and development on the other. On the contrary respondent 3 and 11 questioned our planning capabilities especially in the light of current drought conditions.

Public participation and awareness was acknowledged by respondent 7 as a fundamental component for good planning since the public probably has one of the biggest influences to play where constitutional rights are concerned, but the civil sector is often unorganised (respondent 6), thus this process might take some time.

Table 8. Planning and Strategies is the most important current factor.

Resp.	Quotes	Key words
2	"It still a consumptive resource consumption based plan and that's the struggle we have in this country, we still see growth as being linked to consumption of resources that means water and minerals or whatever it is."	Consumptive resource plan is not sustainable.
3	"It is just exposed, that the drought just exposed us that our planning is not good enough	Disaster management versus planning
6	"So our expectation is that civil society plays quite a fundamental role but it is difficult to get them on board because they are often not organised and they don't have a voice . But it is actually quite a requirement from the department side, from the minister's side even, that there needs to be more civil society involvement."	Civil society is often unorganised.
8	"Well if you look at the different clients I think the Department of Water and Sanitation often has a much longer planning horizon which I think should be the right way anyway. And then your municipalities are very much confined to their political cycles , at least this has been the hype for the past year or two, probably because of this batch of elections. So you get the municipalities looking at much shorter periods of time. That is probably one to three years "	Local and provincial planning cycles.
10	"I think holistically we have got very good legislation , very good planning , but very poor at implementing the legislation or the plans."	Planning not necessarily as big a problem as implementation.
11	"We are not good at planning . Master plan , we still do not have that. If somebody says, give us a blueprint of water supply in South Africa we are going to touch on quite a lot of things"	No clear holistic goal.

Resp.	Quotes	Key words
3	<p>“As well as the strategies, you know what a strategy, once you develop a strategy immediately you have to do an implementation plan. And most of the time that strategy is there and that implementation are either not there or it is there but it is not being implemented.”</p>	<p>Implementation is lacking</p>

5.5.1.2 Governance and Management

Table 9 displays quotes from respondents that are related to governance and management practices.

Ethical considerations are downplayed in management methods according to respondent 7 when he states that WSAs struggle to stay compliant to the very legislation that they have to enforce. Political involvement in decision making at municipal level makes it difficult for municipalities to stay compliant (respondent 2 and 3). Financial management is debilitated by under expenditure of budgets (respondent 3), as well as poor budgeting (respondent 11). Management of human capital is hampered by employment of individuals not because of their credentials, but based on cadre. This is regarded as both unethical and poor employment practice (respondent 1).

Respondent 7 refers to poor governance with respect to the implementation and follow-through of projects. This respondent from the private sector often has to suggest possible solutions to problems with the knowledge that these solutions will probably fail.

Governance is also made difficult due to the numerous stakeholders that are involved in the water industry. Respondent 5 states that it is important to identify common ground between all stakeholders, and prioritize these common interests in the effort to solve problems.

WSA are responsible and accountable for the sustainable regulation of water as a resource. Water managers in municipalities are often frustrated due to the lack of

authority that is ascribed to them. These managers have to gain permission from senior managers, escalating bureaucracy (respondent 8).

Table 9: Governance and Management is the second most important current factor.

Resp.	Quotes	Key words
1	"I will employ you because you belong to a certain group or a certain party, not because you know what you are supposed to know. "	Poor Employment practices
2	"I would say the biggest hindrances we have in this country is that we have two water acts that we think that when the water will attack one law, e.g. when it's in the river it's a different resource and than when it rains on the road..."	Discrepancy in legislation.
2	"That's our ideal situation is that they determine the research agenda, often it doesn't happen and we need to be a bit more forward thinking to say this is what we want to do, do you agree, do you don't you agree but the ideal situation is that it's network city driven so it's very bottom-up which is often very different to research in this country because it's very top down and its national and say this is what we want to do..."	Research seldom bottom up and hence disconnect with reality
2	"...the silo approach we have to managing water that and that relates to both the silo approach both in terms of the engineering versus the land versus the environmental approach to water catchment agency and then the other silo approach between water affairs involving the government... "	Silo approach of management between technocrat and politicians.
3	KN: "There has to be a different model for the municipalities that are not resourced or the poorer communities , which I don't know whether it is something that could be managed at a district level , because at local it does not work	Governing models are different for poorer municipalities.
3	KN: "And also, sometimes there is a thin line between your political and technical, because all the decisions they are done at the political level. "	Different approaches of between technocrats and politicians.
3	"...local government has the powers and functions of providing the services and they are the people who should be dealing with that whole thing as part of the value chain."	Authority lies with WSA's to build the value chain
3	"I can't say financial because I mean national treasury there is so much money there in national treasury and if	Poor expenditure of budgets



Resp.	Quotes	Key words
	you look at some of the fiscal reports....you will see that some of those are returning money back . Not just because they don't have a use for it, because they couldn't convince say the municipal manager, we do need to upgrade , there are other things that serve to take precedent over probably the technical stuff."	Upgrade of facilities remains lacking
5	"Luckily, since there is a greater amount of decision makers, we decided that we should set up a list with touch points. Department of water and sanitation has specific requirements, and so does mining and energy, and environment affairs. We look at which of these requirements are similar in nature , and those we satisfy as soon as possible."	Common interests
7	"Now, if the water service authority does not take on its role as a regulator of service with all the policing and the whistle blowing that is supposed to happen with polluting industries and with themselves also not compliant , you actually have a problem. So they tend to be the biggest polluter in their own environment."	Non-compliance of WSA;s make regulation difficult
7	"And very often in my space the municipalities expect a consultant to then come in and do something for them, but the moment you leave then that whole thing falls over ."	Advice is often not implemented, poor governance.
8	"But then the question comes to say, if then I am the accounting officer or I am responsible to treat the sewage and I have been telling my superiors that the pump has been broken it is not my responsibility to go and get money, give me money. Why should they charge me – so that is where the grey ..."	Decision making is often not in hands of water managers, it reside with senior local municipality managers.
9	Most of the policy, if you look at it, is kind of a general thing. They said, okay, we have a policy, we have a road map, this is what we are looking to do, but there is no really clear direction to what actually we need to do, because it is difficult to do that in the beginning for 10 years	Plans and policies are in place, but implementation remains lacking.
9	There is a real lack of an efficient water governance, lack of better policy and enforcement to access water and all of that	Lack of governance, policy, enforcement
9	"Should we use smart meter or just using dumb meter because if I use normal meter I can instead of deploying thousand meter I can deploy 3 000 with the same cost, and can serve me for now, isn't it? Because now every connection is done, but after few years from that the	Sustainable decision making often making revolves around finances.

Resp.	Quotes	Key words
	normal meter cannot help me further ...With the smart meter issue, if it is automatic, that can make it easier, but still, as I said, because of the limited funding available as if it has come to the director of specific department for them at the end of the day is how to install more meters with the given amount of money. So the choices for him at the end of the day they always go for to have the normal meter instead of having smart meter, for example	
11	"In some municipalities you would have a water section as a stand-alone, you see. Now, if they are part of a bigger engineering section they would compete their budget with all other units in that section . But where they are a stand-alone at least the head of that unit is able to – what I found mostly they will say we are not given the priority."	Competing budget within municipal structure.
11	"Now when you say it is this person in the water service it means that they must be accountable and responsible . They have got the authority to take decisions on water provision. They will ensure that there is capacity. You heard I said they will ensure, they will ensure that there is financial resources, planning, operation and maintenance and the like...for us the main issue is to get a municipality to run the water business the way it should"	WSA has to be accountable and responsible for all aspects of decision making with respect to water provision.
11	"We do more on monitoring and projects, we go inside the site inspection and spot checks, we are requested to verify certain reports that are submitted by other,	DWS has to monitor audit many financial water reports

5.5.1.3 Public participation and awareness

Table 10 provides references with respect to the views on public participation and awareness by respondents.

It is evident from the quotes that civil society is naive (respondent 1, 2, 3 and 9) with regards to water scarcity and drought. There is also evidently a lack of understanding with respect to where water is coming from (respondent 4 and 9). Respondent 6 highlights that in the context of South Africa, there is at least a willingness and interest to engage with communities and civil society. Some of the

difficulties faced when seeking public participation is the difference in classes of society (respondent 6), and also that society is often unorganised (respondent 6, 7 and 8). Respondent 8 stated that one way to involve society is to consider using communities based organisations. Respondent 10 and 11 is of opinion that a greater availability of information as well as higher levels of transparency will encourage public participation with regards to obtaining new solutions to old problems.

Table 10: Public Participation and Awareness is the third most important current factor

Resp.	Quotes	Key words
1	"But with the mines the impact is delayed for 48 hours, sometimes 72 hours, then the politics comes in. You are preferring the mines , the mines are not complaining that there is no water in their plants, but you guys are saying you don't have water. And meanwhile they forget that what the mines are doing, they plan ahead , they respond to what we normally tell them and advise the customer to say, please make provision for at least 24 hours storage so that when we have a breakdown you don't feel it immediately. But they don't do that."	False perception
1	And any complaint that they have, it can be the quality. Either a shortage of water or anything that they are complaining about. Maybe even reporting some activity of some of our employees , maybe that does not supposed to be involved in, they will call us. It is like, yes – and at night, for now, the calls are recorded and then during the day when the – because it is only working from 08:00 to 16:30."	Participation is promoted by new call centre
2	"...in my back yard you know that we urban residents...a part of you know we turn the tap open and there is water there, we don't feel drought in the same way that other people do..."	False perception of drought
3	"Yes, they don't get it , because I still get water in my house, I can still water my lawn, there is nothing that happens to me."	False perception of drought
3	I don't think that we are doing a good job educating the public and also raising that awareness that we need to use water wisely, we must recycle, save water.	Awareness is lacking
3	"...feasibility they had rejection – there was a group	Misperception of



Resp.	Quotes	Key words
	that really was against the water reclamation plant because they thought that the water will not be clean and also they thought that there are better options."	reuse and recycling water
4	"I don't think there is an awareness out there with the ordinary person whose on the street if he does understand where this water is coming from , how does it get to this stage that it comes trickling out of my tap and I must take care of it."	Lack of understanding with respect to the sources of water
6	"So our expectation is that civil society plays quite a fundamental role but it is difficult to get them on board because they are often not organised and they don't have a voice. But it is actually quite a requirement from the department side, from the minister's side even, that there needs to be more civil society involvement."	Civil society is often unorganised
6	"So actually we are also looking at ways on how to improve civil society participation in these partnerships or what role can actually civil society play."	Seeking public participation with regards to water partnerships and programmes
6	"We can always do more but I think in South Africa comparatively there is a much bigger willingness and interest to engage communities, engage civil society."	Willingness and interest is there to engage
7	"...actually, the thing is you have a society on the one hand which is very sophisticated and on the other hand which is very simple and you are trying to manage these two very different things and that makes it very difficult...So we need to organise ourselves a lot more and right now I don't see anyone working on that space. "	Manage the differences within society. Seek ways to organise.
8	"So there should be more engagement at the community level in terms of the ownership . If you look at other countries where they have what they call CBO, community based organisations that would basically run these water stewardship and water related issues to make decisions, especially for rural areas, to make decisions about what should we do to preserve this water."	Need to implement CBOs to help communities with decision making.
9	"Even now, you see the drought is just a few months back finished and everything now will go back to normal life. "	False perception of drought
9	"They take it just as a given and still people don't consider the actual use of the water. For a lot of people	Consumer Ignorance and consumptive

Resp.	Quotes	Key words
	as soon as I can afford it I don't mind to waste water, because I pay for it, so why you need me not to use the hose to clean my car or having a swimming pool, whatever. We don't still have this kind of appreciation for the water at various levels, not as only consumers, even at the utility or whatever	behaviour. Lack of water resource sustainability
10	"...but where there are no triggers the public participation is not that good....maybe not published and shared sufficiently with the public."	Data is often available but not shared.
11	"So that transparency has got its challenges but it also helps that people will also, as you engage you will get to hear certain solutions the way you will not see them."	Require transparency to find solutions
11	"We have improved on public awareness ... I think being out there to communities and listening to what they are saying has really helped us to understand what the ordinary people want."	Public participation is helpful

5.5.2 Results for working environments

Similarly, an analysis was conducted on the most identified current factors for each of the respective working-environments. This provides insight into the thought processes and frustrations of each of these stakeholders.

5.5.2.1 Government

From Appendix 8.1, it is evident that DWS tended to talk mostly about funding as well as human capital factors seen to be currently significant. These factors became evident during the interview with respondent 11; who spoke about graduates that have completed their training with the funding and supervision of DWS at local municipalities. The DWS gets involved in training and provides funding due to the fact that local municipalities cannot afford it. Respondent 11 expressed that when the time comes for the municipality to take over the graduate onto their pay-roll, those municipalities seldom does. This leaves the DWS in a predicament since they cannot keep all graduates on their pay-roll, and the municipalities still do not have the benefit of a trained employee with a relevant skill set to operate water treatment plants as required by the blue drop and green drop guidelines.

When asked about the current skill level respondent 11 answered that due to prior commitments and acknowledgement of apartheid and unqualified skills, the municipal system allowed for recognition of prior learning. The prior learning employees will typically be sent on short courses to improve their knowledge and capacity in operation of water and waste water treatment plants. The predicament is that these employees then expects greater remuneration post training. Though the intention is good, this is still an additional financial burden on an already fragile system which prohibits the extension of the current budgets to employ skilled young professionals. Finance thus stays a limiting factor in the aim towards efficient water stewardship practices.

5.5.2.2 Non-Governmental Organisation (NGO)

Appendix 8.2 illustrates that NGO's are mostly concerned with the participation and partnership of the public and private sectors. Rural villages in a mountainous area often face challenges with respect to waste water treatment works for a number of reasons. These reasons may include non-ideal hydraulic layouts and access to the infrastructure. As a result such infrastructure is usually difficult to develop and maintain. According to NGO's, the involvement of a stakeholder (or local community) is paramount to finding the right solution. Respondent 6, however, highlighted that working with stakeholders is not an easy process and that one must understand the inherent motivation of each of the actors.

The respondents from NGO's also openly shared on the dichotomies in the existing governance and management systems that leave many stakeholders isolated and unable to properly take action. Some of these dichotomies included water management from an environmental compared to a government approach (respondent 2), having a water crisis on hand in South Africa, but water dependant industries not disclosing responsible practices (respondent 6) and not seeing all water as potential usable water (respondent 2).

NGO's were also concerned with regards to ignorant perceptions about water scarcity as well as the lack of planning on the resource and legislation of water, especially within the CMA's.

In summary, the imperative message from NGO's are that the lack of information and weak collaboration of stakeholders still has a long way to go in order to achieve

transparency. The key would be to overcome perceptions and settle for the mentality that we are in this boat together.

5.5.2.3 Private Sector

Appendix 8.3 provides an overview of the most discussed current factors in this working environment. The private sectors seem to lean heavily towards the significance of management and governance systems as well as human capital in current water stewardship practices. Municipal governance and management lacks efficiency with regards to keeping stakeholders accountable for their actions, and not enough work is being done in the improvement of systems to allow for better organisation within WSA (respondent 7). As per respondent 5 there are two important factors, one the machine (or infrastructure), and the other human capital. The one cannot do without the other, but infrastructure would be worthless if not upheld by employees with suitable knowledge. He also states that the monument that is left behind after he leaves is not the physical structures, but the know-how invested in people, because they will be able to uphold physical structures. This could never be the other way around (respondent 5).

Other aspects that also play a vital role according to the private sector are operational efficiency and legislations and policies. Due to urbanisation, an increase in pressure can be seen on systems, which makes operational efficiency difficult. The water infrastructure isn't growing as fast as the pressure on the system is (respondent 5). With regards to legislation and policies, respondent 7 is of opinion that the water service authority is struggling to control polluting industries because they themselves are not compliant. Even when additional help from outside is sent in to put new systems in place; the policies of the municipalities are too weak to uphold what has been built (respondent 7).

5.5.2.4 Research institutions

Appendix 8.4 provides an overview of the most discussed current factors in research institutions. Research institutions were of opinion that the lack of planning and strategy is a vital current factor. According to them, even if proper strategies are in place, these strategies are not implemented (respondent 3). Concerns about who is doing the planning and making the decisions also came to the surface. Even though

technical teams will need to do the ground work, decisions are often made at political level, which can inhibit water treatment plans from functioning optimally (respondent 3). From the interview with respondent 3 it seems as if planning in the research group is being conducted diligently, to make up pieces of the corporate plan, but on government and municipal levels no or little planning is done, and very little is implemented. There is a short-sightedness in government that would rather save money in the present, than to plan properly and allow for better long term results with regards to water stewardship practices (respondent 9).

Another current factor that arises from the research institutions is budgeting and revenue. As per respondent 9, the proper planning and strategy management that will allow for better water stewardship is bypassed due to finances. The revenue issue goes hand in hand with another identified current factor, namely human resources. Municipalities cannot offer individuals with the right skill set the same level of remuneration that the private sector can, and thus must often make do without the proper knowledge (respondent 3). Some vital financial decisions will have to be made with regards to the smaller, rural municipalities. Finances for these municipalities might have to be organised at district level (respondent 3), and water losses will have to be cut not to only regain revenue but to be wiser with our resources (respondent 9).

Research institutions also indicated a concern in the perception of water availability. Public ignorance with regards to not only water availability, but also water treatment is hampering effective water conservation (respondent 3). Other perceptions that is concerning is that of municipal governance, specifically in two areas as identified by respondent 9. Firstly, that water is only important in times of draught. Secondly are the perceptions of municipalities with regards to how effective systems are that is being put in place. With regards to maintenance, two types of maintenance have been identified, namely reactive and preventative maintenance. The first reacts to various crises' as they occur and the second aims to prevent crises' altogether. Municipalities have developed an "active" maintenance approach, which one would expect to be some form of technology, but in reality it just consists of teams of people scouting for potential problems; no long term frameworks are put in place.

5.5.2.5 Water boards

Appendix 8.5 provides a summary of the most discussed current factors by water boards. Water boards identified planning and strategy as the most significant current factors that needs to be considered. According to respondent 1, they cannot plan ahead due to the fact that they are not notified in advance by WSAs, and hence need to deal with problems as they occur instead of preventatively. The inefficiency in planning is also highlighted by respondent 1, who says that planning documents needs to be resubmitted to government annually, even if it has been submitted previously. He described the process that is currently being followed when a system is not meeting the required output, and emphasises the lengthy process of projects always being moved on to the next financial year. As stated by respondents 4 and 10, the planning often isn't bad, but the implementation of these plans is insufficient.

More current factors identified from the interviews were participation and perception. Participation at community level allows for the community to take ownership of water stewardship, like running water programs on using water wisely and so forth (respondent 8). The community can also play an active role in logging comments and complaints, making it possible for WSAs to have a quicker response time to leaks, correct employees, and to advance in numerous other areas (respondent 1).

Public awareness on basic water infrastructure and processes are lacking (respondent 4). Without proper knowledge, the public sector cannot take hands with the industries in accomplishing good water stewardship. Perceptions within municipalities and water boards includes that what worked in the past, remains the best, and that adding technology will result in job losses (respondent 8).

Participation doesn't only apply to the public sector; business participation is also deemed important. One of the instances the public perceives that WB's are giving preferential supply to businesses, like the mining sector. Planning for an adequate water supply is vital in running both mines and municipalities. Water boards supply

water to both WSAs and mines, the WSAs then supply water to communities. Communication from mines to water boards are normally adequate and on time, but communication from WSAs to water boards are often lacking. Mines usually fill up reservoirs before water supply is temporarily stopped for maintenance. However, according to respondent 1, due to the fact that WSAs do not keep water boards informed about their water status, communities are often left without water. This then results in the negative perception that mines receive preferential treatment. Government participation plays an imperative role as well. Respondent 1 is of opinion that privatisation of the water sector will allow for improved distribution of funding and management of this resource. Due to the fact that water is a national asset, this cannot happen however. The answer then lies in government taking the hand of the private sector so that an improvement in the distribution of finances and resource management can be seen (respondent 1).

Obtaining and maintaining human resources also plays a significant role in the water industry. Respondent 1 comments on employment of individuals that does not necessarily have the required skill set, but conforms to a group or party. In the long run this can truly damage the industry. South Africa does not have a lack in the skill sets that are required to run efficient water services (respondent 1), but two reasons are offered for these individuals not working in the water sector. The first is urbanisation; graduates and post-graduates often want to live in cities rather than rural areas where their skills are sorely needed (respondent 10). The second reason is a financial one. The water sector cannot pay the same salaries as a graduate would attain in the private sector (respondents 4, 10). Government, however, has seen the importance of employing trained individuals and are currently training about 1 000 artisans according to respondent 4.

As indicated by various other sectors, finances again made its way to the discussion on current factors that play a role in water stewardship. On municipal level planning for financial surety is made difficult by having "too many fingers in the pie" (respondent 1), and planning for projects is made just as difficult by the apparent uncertainty of capital provision by government (respondent 4). Inter-municipal communication with regards to budgets and financial planning is also infinitely lacking, making it difficult for those municipalities that are trying to allocate funds to the adequate areas to do so (respondent 8). Government has come on board to try

and allocate funds to the training of employees, so that municipalities can attain human capital with the required skill set, but according to respondent 8 municipalities do not have finances to take these graduates onto their payroll. In contrast, respondent 10 is of opinion that there is no lack in funds in South Africa, the allocation of it should just be improved.

5.5.3 Analysis of perceptions of discussed factors in Research Question 1

As can be recognised from the previous section, the current factors identified helps to give an indication of what the WSA as a whole, as well as the various work-sectors deems the most important. It does not, however, distinguish whether the statements that were made on the current factors during the interviews were positive, neutral or negative. In an example, a work-sector might have mentioned governance and management often, but in a positive statement, while they talk negatively about finance. To take this into consideration, super-codes were developed on each current factor. For the purposes of this paper, the neutral codes were not included.

Positive and negative super-codes for each of the top ten current factors are displayed in Table 11. As can be seen, the negative statements far outweigh the positive statements. The three current factors that scored the highest negative values are indicated in red, while the three current factors that scored the highest positive values are indicated in green.

Table 11: Positive and Negative super-codes for the top ten current factors.

Top ten current factor super codes	% Time Positive	% Time Negative
*CF:BusinessBusiness&Participation	14%	86%
*CF:Planning&Strategy	9%	91%
*CF:Governance&Management	10%	90%
*CF:HumanResourcesHumanResources	30%	70%
*CF:Legislation&Policies&Conserve &	40%	60%

Top ten current factor super codes	% Time Positive	% Time Negative
*CF:OperationOperation&Monitoring&Reporting	14%	86%
*CF:PublicParticipationAwareness	44%	56%
*CF:FinancialBudgeting&Funding	4%	96%
*CF:Perception&HumanBehaviour	0%	100%
*CF:Stakeholders&Partnerships	52%	48%

5.5.3.1 Negative current factors

The three current factors that were found to carry the most negative related statements across the working-sectors were “planning and strategy”, “financial, budgeting, funding and salary” and thirdly “perception and human behaviour”. To gain a holistic understanding, co-occurring codes were identified to show the cumulative trend of the negative related statements.

The negativity around planning and strategy was often around governance and management, as well as infrastructure. It seems as if respondents feel that not enough is changing, both in government and in infrastructure.

As per financial budgeting as current factor, human capital as well as legislation and policies are seen to co-occur the most. The last mentioned often entails funds allocation as well as how these funds are managed. With regards to human capital there appears to be a frustration around municipalities not being able to appoint a work-force with the appropriate skill set, as well as certain departments not being able to maintain graduates due to financial constraints

The negative statements around perception are mostly accompanied by water scarcity, indicating a lack of awareness, or ignorance, in our water dilemma. Individuals also do not accept responsibility for this resource.

5.5.3.2 Positive current factors

The three current factors with the most positive statements included “legislation and policies”, “public participation” as well as “stakeholders and partnerships”. As was

done with the negative statements for the current factors, co-occurring codes were isolated to give some indication to areas of importance.

One of the co-occurring codes for “legislation and policies” includes “planning and strategy”. Some respondents felt that a lot of planning goes into the water policies. The other co-occurring codes comprised “operation efficiency” and “public participation”

Although most public participation comments were negative in nature, the positive index for this factor was still one of the highest. Co-occurring codes in this instance included “programmes and tools”, “training and education” as well as “legislation and policies”. Many of the positive statements entailed a self-reflection of working-sectors on how well they are doing, often in education of the public. Statements also included insight into the importance of public participation as well as South Africa’s willingness to engage communities.

Stakeholders and Partnerships scored the highest in positive statements, obtaining a score of 52 percent. Common co-occurring codes include “operation efficiency” and “public participation and awareness.” Partnerships were regarded as inclusive of civil society, government and business.

5.5.4 Conclusion

The top ten out of 30 current factors accounted for about 60% share of voice and is illustrated in Figure 5. The three most important current factors are planning and strategy, governance and management and public participation and awareness.

Although planning and strategy was the most discussed factor, it is predominantly perceived with a negative connotation. According to the research institutions, even if proper planning and strategy is in place it is not implemented. Respondents feel that poor governance and management is often the reason for this. NGO’s highlighted that the inherent motivation of stakeholders must be identified when considering planning and strategy.

Both NGO’s and the private sector spent a lot of time talking about governance and management within the water sector. They find it important to solve many of the dichotomies in legislation and governance, with emphasis on miss-placed

perceptions that has a substantial impact on the way we govern and manage. They ascribe many of the short falls in management as a lack of attracting the right human capital and failure to build partnerships.

With respect to public participation and awareness the country came a long way as seen by many of the positive ratings. NGO's, research institutions and water boards emphasize that without public participation and awareness conservation solutions will be difficult. The interaction between the public, the municipalities (WSA's) and the industry is seen instrumental to accomplished good water stewardship practises.

On a very positive note, many respondents do acknowledge that legislation and policies are well formulated within the context of South Africa. This provides the country with a good foundation to build on. It is considered that future planning and strategy, operations and public awareness will play a massive part in this.

5.6 Research Question 2

The detailed questionnaire that was followed during the interview process is provided in Appendix 1. The second research question was formulated as:

What are the most important future factors that will play a role in improved future water stewardship practices, and that may transform water providers into world-class water stewards?

Results for research question two was analysed using two approaches, firstly future factors were analysed according to the results from all respondents, and secondly according to similarities amongst working sectors. Additional information regarding future factors identified amongst working sectors are presented in Appendix 10.

5.6.1 Results for Research Question 2

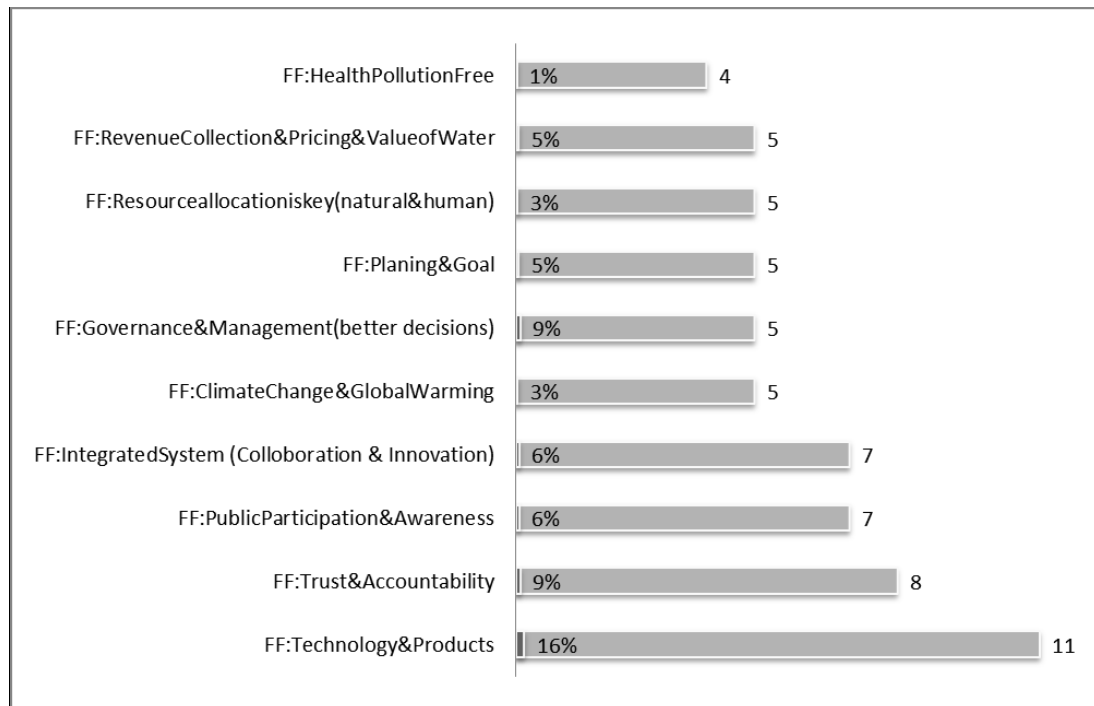
Future factors where identified using the ATLAS.ti Codes-Primary document Word Table. The word count of the respective future factors where sorted from highest to lowest before calculating the percentage share of voice that each respondent designated to each factor. Twenty future factors were identified from the group of respondents. Figure 6 indicates the top ten future factors ranked according the

number of times it was mentioned as well as according to share of voice. The full list of future factors is provided in Appendix 10.

It is remarkable that the most important future factor was identified as technology and new products. All respondents identified this factor as a significant future factor. Sixteen percent of total time spent talking about future factors were spent on discussing this one issue. Respondents often discussed it in collaboration with factors like governance and management as well as with integrated systems that are used for collaboration. Results shows that the next two significant factors include accountability and trust as well as public participation and awareness. These three factors made up almost a third of the total discussions around future factors.

An association was found between identified current and future factors, with five current factors resurfacing as factors that will be important for transformation in future. Other acknowledged factors included the importance of the establishment of integrated systems, improving on government and management, as well as better resource allocation both with respect to human capital and the natural environment. The uncertainty of climate change and global warming also appeared on the radar.

Figure 6: Top ten identified future factors that can play a role in future water stewardship practices.



A network view (Appendix 14) of the top ten future factors was created to identify associations between the individual future factors. This network view highlighted the importance of both human and natural resources to drive technology as well as to find sustainable solutions. It shows that new technological implementations will prove challenging without the correct human and natural resources.

5.6.1.1 Technology and products

All 11 respondents stressed in one way or another that technology and products will play a massive role in innovative solutions that may help improve water stewardship practices. Some of the most important quotes with regards to technology and products are highlight in Table 12. Respondents 1 and 10 agreed that technology will help curb pollution and that it could assist in improving our catchment management strategies. Basic technologies (fit for purpose), eco and green technologies are all seen, by respondents 2 and 11, as an important step into the right direction with respect to sustainability. Technology is said to provide a platform for early warning and communication systems by respondents 3 and 6.

Table 12: Technology and Products is the most notable future factors across the sample population.

Resp.	Quotes	Key words
1	"The sky is the limit when it comes to technology in terms of avoiding pollution of our catchment ."	Water resources protection
2	"So the sanitation space is great for innovation, the other space which is my particular passion is green infrastructure where we are very far behind and investing in something like sustainable urban drainage, an alternative which is about managing the catchments"	Green infrastructure
2	You know eco-products and all sorts of things and low-flow taps	Eco products
3	Probably ICT based plan, that is also the same as the early warning systems . Also, decision support systems, and that are ICT based.	ICT could support early warnings
6	"...but also the technology that would control water usage beyond what is now within the level of awareness of each and everyone	Control water usage
10	ICT and drones and that type of technology could make a big difference in us getting information on	Technology is used to save water and

Resp.	Quotes	Key words
	our resources on pollution, illegal use of water or water resources. I think there is quite a big role to play there.”	water resources
11	there are those people who do not understand technology issues, but for me I like the fact that it is not about where you are, anywhere where you are you will be able to transmit that information.	Human behaviour Connected
11	Appropriate technology within the context of climate change in relation to any infrastructure development that is being – I always used the houses, RDP houses, they must start thinking about the small systems that will take less water, re-use of grey water.”	Technology Climate change Basic Technologies (Fit for purpose)

5.6.1.2 Trust and accountability

Accountability and trust was mentioned by eight out 11 respondents as a critical factor for moving forward. Respondents 3 and 4 was of opinion that accountability stretches across several aspects including water governance, technology adoption, operations in addition to the decisions making behind business and politics. Accountability was regarded as the responsible and timeous notification of concerns and disasters, including aspects such as mismanagement, pollution, drought and flooding. It was referred to as accountability with respect to a governing role, supplier role and business role; promises that are made and not kept.

Table 13: Trust and Accountability is the second most notable future factors across the sample population.

Resp.	Quotes	Key words
3	I think their accountability there , they need to really rethink because, like I said, the resources and things aren't working and it is the municipalities	Being accountable for poor performance
3	“It is the whole of South Africa. I can tell you now, because like I told you that South Africa is very politicised If I take an example, but you know someone once said that I don't know why we are still struggling with operational problems, one country has automated the whole thing. But really we can't	Transparency with regards to politics will be required to overcome issues around labour and unions.

Resp.	Quotes	Key words
	because the labour and unions are going to make so much noise because of the number of jobs that are going to be lost”	
5	“but the delivery or the guarantee of the promise takes much longer than what was initially promised.”	Promises that take time effects trust.
8	“But from the government’s point of view in terms of the membrane technologies we are coming but we are still of the view that it is high tech who is going to operate them and they are going to cost us a lot of money. So we have not been that much receptive as well.”	Technology
10	I think you have got to take away the bureaucracy and professionalise from the point of view of giving them the authority and accountability to make decisions	Reduce bureaucracy to promote governance and accountability.
11	Not because you don’t make money out of it, you got[?] money because this leakage is happening after the meter, but for them it is to start to reduce the water consumption out of these big consumers, yes	Accountability with respect to the resource.

5.6.1.3 Public participation and awareness

Seven out of the 11 respondents considered public participation and awareness to be an essential future factor. Respondents 2, 3 and 8 believed that improving communications with regards to water related concerns, ongoing research initiatives and up to date information around resource sustainability will encourage public participation. The implementation of programs was also discussed as a viable method of improving public awareness (respondent 7). Public participation holds a key that cannot be replaced by any other factor; without active involvement from this stakeholder sector, implementation of programs and technology is deemed insufficient (respondent 9).

Table 14: Public participation is the third most notable future factor across the sample population.

Resp.	Quotes	Key words
-------	--------	-----------

Resp.	Quotes	Key words
2	"..had a community-based approach , the bulk of their money was spent not on developing technology and infrastructure but on engaging with the community and that's the other shift is that you go to people"	Community based approached will enhance community engagement and participation
2	"I know how water data , infrastructure and our arrears and stuff have fallen into disrepair; over half the sites is not working...Where is the up-to-date information showing who has access to water?"	Sharing data will bring more awareness
3	"I think it is public participation and communication . I think those are important because those that speak to water conservation , saving water, recycling water, using water wisely and also making people aware that really we are a water scarce country"	To save water and awareness of scarce water resources
7	"Someone needs to organise the communities into understanding that you have this tool which you can use and this is the benefit of doing it. So we need to kind of roll out some programs , awareness programs from water stewardship, sustainability, which actually say if you see someone polluting call the hotline number, make a noise about it..."	Implement tools and programs to promote public participation
8	"In terms of communication it can be improved as well and I think that the rest of – in terms of things like your consultation and public participation other countries like Singapore they know about their waters in and out."	Communication to promote awareness
9	"In fact without this participation we cannot go anywhere. Like government alone, even whatever they develop from policy cannot solve the problem alone. In the private entity, even if they were to bring technology and we make it difficult for adaptation of such kind of technology he cannot use it."	Both policy and technology alone will not bring success without participation.

5.6.2 Future factors identified by working environments

A similar analysis was conducted for each of the respective working-environments. This dissection provides a means to evaluate and compare the different views of these environments with regards to the factors that will be important for the future. Quotes with regards to the main future factors for each working-environment are provided in the Appendix 11.

5.6.2.1 Government department (DWS)

Appendix 11.1 provides some of the most prevalent future factors as seen by respondent 11. Working for the DWS she placed emphasis on public perception, and how we should change the language that is used to enable better understanding in the civil sector. Ideally, this will result in more trust and accountability.

DWS also discusses how green economies and basic technologies could be used to overcome some of the existing challenges, especially with regards to sustainable solutions. A definite concern regarding management of security with the implementation of technology was identified. Other drivers behind her thinking included the uncertainty of climate change and what that may hold for the future.

5.6.2.2 Non-governmental organisations (NGO's)

Appendix 11.2 provides the principle future factors as seen by NGO's. They were most interested in the possibilities that technology provides in going off the grid (respondent 2). Since they are humanitarians, this will open vast opportunities in the field. Much of technology they refer to includes green infrastructure and eco-products (respondent 2). They do, however caution that technology alone cannot engage with people and that awareness and participation will be necessary in the development thereof (respondent 6). They also point out that innovation will most likely come through the sharing and collaboration of data (respondent 6).

5.6.2.3 Private Sector

Appendix 11.3 provides several future factors as seen to be crucial by the private sector. The private sector is frustrated since they, as consultants, often set up plans and give advice in the WSA environment, but as soon as they hand it over, nothing comes of these projects. It is thus not surprising that they identify governance and management as the most important factor for future water stewardship practices (respondent 7). In addition to this, technology was identified as a strong driver that will enable better governance and water sustainability. One example of this is the monitoring of pollution using ICT (respondent 7). The private sector firmly believes that if the municipal water sector (WSA) managed to convey a sense of trust and accountability, more collaborations and integrated systems can be developed (respondent 5). The way that water is valued, and the price thereof, needs to change if we want sustainability (respondent 7).

5.6.2.4 Research institutions

Appendix 11.4 provides the prominent future factors as seen by research institutions. Research institutions identified that new technology and products may be a vital factor in future management of water, and seems enthusiastic in the role that they will be able to fulfil in the development of these technologies (respondent 3). They identified potential benefits that will accompany the implementation of technology, including data development (respondent 10). They also noted that human resource allocation is fundamental in finding the right solutions, recognising balancing act of cost versus skill in human resource acquisition (respondent 3).

5.6.2.5 Water boards

Appendix 11.5 stipulates the essential future factors as described by WB's. It is apparent that WB's are dissatisfied with the professional nature of the WSA environment, with who they have daily contact. They are of opinion that trust and accountability is earned through responding to queries on time (respondent 1), while a lot must be done to overcome perception of technology (respondent 4) as well as to remove bureaucracy and professionalise the environment to attract young talent (respondent 10). They also foresee that communities will require help to make better future decisions (respondent 8).

5.6.3 Conclusion

In summary, technology and new products was seen as the predominant future factor. It does seem like most working-environments are of opinion that ICT can solve many of the existing and current issues. Yet a lack of professionalism and management, and the associated lack of trust and accountability has been identified as major regions in need of change in the South African water sector.

5.7 Research Question 3

During the preliminary interviews, the respondents found it difficult to elaborate on the third research question. To help prompt the respondents for deeper insights the Kaleidoscope Five-S Future Fitness Framework was applied. The framework is set up to ask five easy questions to test the anticipated stocks and flows in society as to whether the product (like ICT) in question is set to make our lives more meaningful and why. A detailed questionnaire is provided in Appendix 1. The idea behind

applying the five prompts was to discern what the opportunities (enabling the use of the product) or challenges (things that will prohibit the use of the product) were.

The third research question was stipulated as:

- How can ICT complement the sustainable water balance frameworks in order to enhance water stewardship and what are the opportunities and challenges associated with ICT?

A few examples of individual coding that was conducted on the third research question are stipulated in Appendix 12.

5.7.1 Results for Research Question 3

Table 15 highlights the coded percentage of time that respondents referred to opportunities and challenges. Interestingly, the earlier disparity between negative and positive ratings is reversed in the case of ICT. Here it is observed that a higher percentage of time was spent on talking about the opportunities that ICT creates, compared to a much lower percentage of time talking about the challenges.

Table 15: ICT Opportunities and Challenges

ICT Factors	%Time
ICT:Opportunities	60%
ICT:Challenges	40%

5.7.2 ICT Opportunities

Various benefits of ICT systems were identified by respondents as per Table 16. Firstly, ICT could play a role in eliminating human errors and improving data accuracy of operations. Secondly, it could provide the person in charge, like the controller, with real time data that removes uncertainties about the current status of the operating system. Thirdly, it would also allow operational information to be shared with the relevant people directly and instantly. It might also play a vital role in allowing for a means to deal with underperformance in a variety of occupational levels and it can facilitate in the altering of perceptions.

Table 16: Identification of ICT Opportunities

Resp.	Quotes	Key words
8	<p>"...The one that may encourage it, in terms of ICT, it will be percentage errors, meaning when you use ICT, especially for if you want to use it for running the plants, there will be less percentage error because there will be less interference entirety, interference and that's the flaws. It will help us..."</p>	<p>More accurate data</p>
9	<p>"And ICT is the right enabler for that because at the end of the day it can provide you with a real time data and monitor various aspects within the network that can give you clear idea what is going on within the water distribution network and all the usage of all the abnormal events and so on, which makes it easy for whether the decision maker, whether the maintenance operation team and various value chain of the water to make it easy to manage and [indistinct] with such kind of technology that ICT can provide for us."</p>	<p>The positive effect of real time data on decision making.</p>
1	<p>"In fact ICT cuts off the lag between what is happening and what gets reported to the relevant people."</p>	<p>Faster information means faster response times.</p>
4	<p>"So that is part of communicating to those plants so they are the enablers, they ascertain enablers to make things easier for us, we are able to see other different plants that belongs to Rand Water are enabled to see the reservoir is there, at what level they are so that if something happens here from the maintenance point of view I'm losing two or three pumps, I should know exactly what impact it can do with those reservoirs and that information I do not have to pick up the phone, it's just information that is available in front of me currently."</p>	<p>Ease of data.</p>
2	<p>"Where is the up-to-date information showing who has access to water? So the next indicator where I was looking for water is downtime water downtime of services that we start sharing information about</p>	<p>Data availability allowing for perception change and performance</p>



Resp.	Quotes	Key words
	<p>how and in some cases (inaudible 56:32) the government gets the bad rap for these things but when we start sharing the data and we finding platforms enable easy access to the data then we can say oh! do we start dealing with perceptions as well as underperformance, so both the good and the bad.”</p>	<p>enhancement.</p>
2	<p>“There is no group data particularly for water at most government levels, boundaries don’t match so the local government boundaries doesn’t match the catchment boundaries, it doesn’t match the system, it doesn’t match with National (inaudible 54:29) so from a city perspective they can get data from the utility or from Rand water but who leads your holistic water management (inaudible 54:37) and we don’t do it and we do not share data..”</p>	<p>Data sharing enabling holistic water management.</p>
3	<p>“Resources, talking about your metering, to know, or early warning systems that would measure the quality or the quantity and we are also looking at how ICT can strengthen governance and bring about institutional reform, change the way people do things. And also then to change the consumer behaviour as well as give the society a voice.”</p>	<p>Role of ICT in improved governance and management.</p>
6	<p>“In terms of supporting planning at catchment level and there is a lot of modelling[?] going on already but I think that this can even be improved, it can be made more user friendly, it can be made more accessible to different stakeholders, again also to industries”</p>	<p>ICT role in planning and partnerships.</p>
9	<p>“Utilising ICT tools can enhance the forecasting various aspects of the water system and can contain a better modelling for that huge rather than just based on the historical data.”.</p>	<p>Taking the guessing out of forecasting.</p>
10	<p>“It definitely can, we have seen a lot of in terms of leak reporting, vandalism reporting, those type of – getting the public involved through their connectivity can make a big difference.”.</p>	<p>Public participation using technology, assisting in improved management.</p>
7	<p>“...pollution reporting could be done with ICT, so you get normal members of the public reporting hot spots for pollution and so on which could actually go a long way in helping municipalities to monitor pollution.”</p>	<p>Public participation using technology, assisting in pollution control.</p>

Resp.	Quotes	Key words
1	<p>“Maybe you have a meter inside the house or something that will tell you your average water usage has been 10 litres per day, suddenly now you have doubled it, or it is 15 or it is increasing. Then you know instantaneously that there is water, there is a leak somewhere in your house, rather than waiting for the end of the month, if you are lucky, where the meters are read every month. Or you wait for two months or three months before you pick up that you have more than 10 times doubled – it has happened to me myself whereby my bill went up to 15 000...”</p>	Public sector ICT in resource management
11	<p>“Let’s say ICT from an efficiency perspective – responsiveness. I should be able when I get a – I get a lot of emails, people asking for something, I should not be saying let me find out from emails what is happening. I must be given access to some information ...”</p>	Access to information

ICT systems can also be used in governance and management to provide a holistic view of data (respondent 2) as well as in creating a platform to facilitate institutional and consumer behavioural change (respondent 3). Since both governance and public awareness fell under the three most important current factors, this is a significant benefit that ICT would be able to deliver.

It becomes apparent that ICT is perceived as a tool that conveniently connects the public to become more involved with matters of national interest. On the other hand, it can help inform the public of excessive consumption or potential catastrophes (like leaks). This can halter ignorance and facilitate meaningful and sustainable solutions. ICT could also provide a means for planning, support and accessibility to catchment area information. Respondent 9 mentioned that an ICT systems will take the guessing work out of forecasting, which would result in improved ability to manage water systems.

5.7.3 ICT Challenges

Table 17. provides a number of ICT challenges as identified by the respondents. The major challenge ICT solutions are currently facing may be the expense linked to

it. Since the cost of water is still low when compared to other utilities, ICT might not seem as a viable option currently. Unemployment is one of South-Africa’s biggest problems, and there seems to be a fear amongst respondents that implementation of ICT will be a direct cause of even less jobs. In contrast to this, there is also the concern that even though ICT is implemented, ground-workers will still be needed, and this means double the cost to municipalities.

Table 17. Identification of ICT Challenges

Resp.	Quotes	Key words
8	<p>“ Looking at the hindrance on why maybe we do not want to implement it, it will go back to the capital funding, it might be huge cost which some of the local municipalities might not want to invest. The other one might be from the practical side of things, politicians thinking that they want to put this but that it might start to loose these jobs, once we are evenly [indistinct].”</p>	<p>Capital cost of ICT, and potential job losses.</p>
2	<p>“I think cost is definitely a prohibitive factor but I think that needs to be into the price, water pricing as well so that, it’s like electricity I think we will start seeing the tipping point where some of these technologies become more affordable because of the cost of water but also there is, we start creating industries around producing these water-saving technologies.”.</p>	<p>The association between cost of water and potential cost of ICT.</p>
9	<p>“they have various kind of ICT systems to use within that department, but still financial issue problem, they have a resource availability problem at the level of plumber, but they still in some certain extent they still believe in that kind of traditional way that can help them.”</p>	<p>ICT implementation is difficult without established basic infrastructure.</p>
1	<p>“...when we have a SCADA system, the operator is used to touch a computer to run the plant. I am from the old school, when we have that in this plant things just go out the window. You can see the operator just doesn’t know what to do. Whereas if you take the old guy and you say, there is now your SCADA system has failed, run the plant manually, then the guy will just run the plant.”</p>	<p>Lack of skill and wrong perceptions around ease of process.</p>



Resp.	Quotes	Key words
1	<p>"The only thing that can discourage is when you have all those things installed and then you do not have people to look after or to make them work, as they are supposed to work. That can discourage you. But I do not foresee that the way it is going, and if people know where to report what when it goes wrong, then they will be able to utilise the ICT to its optimum."</p>	<p>Lack of skill in running and maintenance.</p>
3	<p>"It needs to be integrated because the municipalities they do not only provide water but they provide a whole lot of other services. So if [indistinct] models can look at integrating all the services into the one, then probably that could work, because at the moment it is very difficult to have a separate ICT system for water, and have a separate ICT system for health, and a separate ICT system for fees collection."</p>	<p>The need for integrated ICT systems.</p>
5	<p>"But this can also mean that it can become very impersonal in the working environment."</p>	<p>The impersonal nature of technology.</p>
6	<p>"Ideally information is shared freely, but we also know that there are limits, especially working with the private sector because they are concerned about competition and competitors knowing, and about government using that information against them..."</p>	<p>Security around data sharing, and the associated competition that arises.</p>
10	<p>"I think it is always the privacy issue, and also the dangers that comes with that. Okay, now this person will know that okay I am – because like we have spoken about inside the security, those are the challenges that we face. The IOT conflict with the internet security and privacy issues.</p>	<p>Data privacy.</p>
9	<p>"You see at the end of the day security is a very important factor, security and privacy, but there is still need to prevent the utility to know exactly what you are doing. So the idea is not to make it public for everybody that this is a lot of water that you are using, because at the end of the day it is against the Public Act"</p>	<p>Privacy with regards to protecting public rights.</p>
7	<p>"...but from an IT perspective you probably need to set up systems that would be able to absorb that much</p>	<p>Associated system set-ups, cost and</p>

Resp.	Quotes	Key words
	data as well..."	management.
9	"Yes, because the regulator can play a critical role in this kind of technology, because now if you look at [indistinct] they are suffering from the GSM connectivity, using for example smart meters and using the cellular network. But this extra fee is required, who will pay for it, we must charge it to the customer and they will pay it or what? Now if the regulator, for example, ICASA can, to encourage the smartness within the South African environment, if he can allocate certain kind of frequency that can be used just for utility, it could be not fully free of charge but at least with a very low cost , that we encourage the smartness in the city, isn't it, as far as communication..."	Cost of running ICT, and identification of alternative methods to make running cost less.
3	"The biggest issue, also with ICT, is that there aren't any incentives at the moment, that if I free water use and I see me I use more than you, what the incentive that will make me say, okay, I am going to beat my neighbour, I am not using."	Creating awareness, possibly using incentives.
3	"...problem that we have at the moment is that people do not want to use their data that they buy that is so expensive to actually help a city do their job.	Cost of running ICT, and identification of alternative methods to make running cost less.
11	"But if the consumers are not wiser about understanding their water bill. You know the same thing about solar energy, I mean it sounds expensive when you start but the results financially are very good . So the same with water, it is how I see it."	Perceptions around ICT cost.

Apprehensions to ICT systems include the physical running of the systems. With the possibility of ICT systems failing, ground personnel will need to know what to do. The concern was two-fold; firstly how to educate longstanding employees to operate these systems, and secondly, where to find employees with the know-how of these systems to implement and maintain it.

Another challenge that was identified with regards to ICT applications was the management and governance thereof. The process of implementation of ICT will need to be planned with detail, as municipalities will need the system to work for various services that they supply. This would include not only water, but waste removal, healthcare, amongst others. Putting ICT systems in place might also result in very impersonal environments, this challenge will have to be well-managed, especially in employees with more experience in the traditional methods.

ICT systems inevitably mean more data will be generated. This data will provide a passage to better resource management, planning and many other positive aspects. Thus said, it can also become a privacy and security issue. Several respondents mentioned security as a cause for concern. Sharing of data and selling of data has become a viral trade, and this opens whole new avenues into fraudulent practices. Some respondents also identified that making an individual's data public is against the public act, thus security should be put in place to protect the public.

As mentioned earlier, one of the biggest constraints to ICT implementation is finances. The maintenance and management of these systems will also require on-going fund allocation. Systems will need to be set up that can manage the massive amounts of data that will be generated.

Perceptions around ICT have a long way to go. We live in an incentive driven society, and without incentives, implementation of ICT might be difficult. There is the perception that, as respondent 11 rightly noted, the capital cost of ICT will take too long to recuperate from. It may be compared to solar panels, the capital cost is high, and the payback period seems too long.

5.7.4 Conclusion

As shown in Table 15, a greater amount of time was expended by respondents talking about the opportunities around ICT systems in comparison to the challenges. The reason behind this might be that not many ICT systems are currently in place, and respondents are hopeful in talking about the prospects of ICT in water stewardship practices. Some of the most important factors that were identified that will count in the favour of ICT are:

- Real-time data

- Eliminating (human) errors
- Holistic view of data
- Facilitate behaviour change
- Support better planning
- Connect stakeholder for participation and collaboration.

Some very valid challenges have, however, been identified and should be taken note of before considering implementation of ICT systems. The financial burden of including technology in our water stewardship practices was at the forefront of concerns, especially if the basic water infrastructure that it will be serving is not properly maintained. Human resources were also a vast burden, both with regards to job-retention in the midst of mechanisation, as well as the training and investment that will have to be made in this regard.

5.8 The Complexity of the Systems

In the interest of conformability, quotations have been included to elaborate on the complexity of human behaviour in current municipal systems. As discussed under the Cynifin framework, factors can be classified into “known” or “knowable” domains, but some factors are more complex in nature and do not have a linear solution. This demonstrates that over and above the known factors at play in the environment of WSA, there are several underlying factors that are more complex, and can influence the outcomes.

5.8.1 Results for Complexity Factors

With the discussion regarding the possibilities of water reuse, respondent 1 stated that people are averted by the idea that they are drinking water that has been through somebody else’s stomach. He reckons that this will not be an easy problem to solve in the near future.

Table 18. Identification of Complexity factors

Resp.	Quotes	Key words
1	"It is a mind-set, it is a difficult thing."	Perceptions
2	"...at local level in terms of strategic planning, it's about partnership and it's about understanding what local government needs to do in order to enable business, to enable communities, to enable growth and what's the world water looking like. So the language is changing , the conversations are changing which is important and then how do you enable that?"	The role of government in enabling partnerships.
2	"Our developments are not where water is so spatially its disaggregated you know so we, water is not where people are, Joburg it was here because of mining and that it's been majority controlled by and having a hugely bulk infrastructure, we do not see in many other places around the world but the conversations are changing now so it's about development , it's about enabling, it's about transformation and that means partnerships ."	Transformation of old ways of thinking, into inclusion strategies.
2	"There's two ways you can bring a change by killing off the old ideas so we beat them to death and then we bring in a new one, that's generally how science works because you first disprove the old stuff before you bring in something new or you be a lot more, I won't say the word revolution but it's not really, innovation where you come with something completely new that takes you in a different direction quickly and we more on the first type of information."	The methodology around facilitation of change.
2	"...what Denmark did was changing behaviour and enabling the economy but also about using technologies to be better."	The complex system linking behaviour to technology to economy.
6	"Maybe they read about it in the newspaper, or there have also been these advertisements on the highways and what what, so that is actually quite a lot, but it doesn't translate into behaviour changes for the population."	Behavioural change is multi-dimensional, water must be understood, not just known.
6	"I mean on the one hand we are seeing a water crisis in South Africa, which has also been confirmed by experts, but on the other hand water dependant industry sectors do not seem to see any reason to	Contrasts seen in what is the supposed right thing to do, versus what is being

Resp.	Quotes	Key words
	disclose above and beyond what they used to do.”	done. Human and system ethics.
9	“They take it just as a given and still people do not consider the actual use of the water. For a lot of people as soon as I can afford it I do not mind to waste water , because I pay for it, so why you need me not to use the hose to clean my car or having a swimming pool, whatever. We do not still have this kind of appreciation for the water at various levels, not as only consumers, even at the utility or whatever. Because if you look for the action we are taking it is not really serious.”	Perceptions, self-righteousness.
7	“I do not think the water sector will be able to go that far very quickly, unless we delve into a massive crisis , which at the moment looks distant”	Crisis may bring change in perceptions.
2	“Ya and I think then at the local level the social dynamics about access to water and what that means and the politics of that. It’s very we’ve gotten to a point in this country where politically it’s okay to say if you do not pay for electricity we’ll shut it off or if we dealing with non-revenue, or as a way of dealing with it, it’s not that flexible with water. There’s also a constitutional right for water so people who aren’t paying, you can’t switch it off”	Water as a constitutional right, but individuals not respecting it.
2	“ Rand Water recommended a level zero point five do not ask now how they determined their water restrictions levels, they recommended a month and a half ago to the minister of water affairs to say we need to put through these restrictions in Joburg and Gauteng, they haven’t done anything with it and I can tell you now they won’t do anything until the last day of elections. So there’s very much an electoral.”	Lack in motivation and responsibility as a factor.
7	“So it is how do you embed technology into the organisations that they become a way of life, especially for your municipal water service authorities.”	Lack of adoption of technology even if it is available.
7	“I think one of the challenges is really your human capital turnover , as long as you have a very high turnover you cannot have that transfer happening.”	High turnover of human capital has massive effect on transferring knowledge.
9	“Even it has come to the economic and social I think then we have unique, it could be even maybe we share it with other African countries, but we have a	Complexity of economics and politics, and how that

Resp.	Quotes	Key words
	kind of complex economic and political system that affects sometimes the performance of the water, the way you manage your water.”	influences water management.
7	“Exactly. You will find probably your city of Jo’burg's and your Tshwane’s are a lot more stable, yes, because though they are municipalities there is a very good separation between your political power and your technocrats , and I think that is always the most difficult part to manage.”	Influence that political power has on water management.

As can be recognised from the quotes in Table 18, many complex situations are imparting on the functioning of water sustainability. Respondent 2 warns against the unique challenge that South Africa faces with regards to how disaggregated our water supply is. Cities were not necessarily built around water sources like we see in most other places around the world. This means we have a greater need for water infrastructure. The focus of our water industry should be on future development and how to enable or transform the status quo via partnerships.

Respondent 2 goes on to elaborate on the methodology used to facilitate change, and the complexity thereof. He states that the only way to get rid of old ideas is to either let it die off over time or by disrupting it with something swiftly and completely new. This is exactly what Denmark has accomplished according to her.

Human behaviour and change doesn’t occur voluntarily. Although many awareness campaigns around water responsibility are aired, neither the general population (respondent 6 and 9) nor businesses (respondent 6) seem to see the need to change. The approach to changing perceptions might have to come from a place of understanding instead of a place of just knowing. It entails an ethical principle. This then gives rise to the question of what it will take to bring change. Respondent 7 provided a simple answer by mentioning that the only thing that could bring a change to our behaviour would be a massive crisis.

Municipalities faces the challenge of embracing new technologies and to make it part of the current structures. This will require skill-sets that they may not have access to. They also have to aim to prevent a high turnover of human capital, since

this will prevent the retaining and spread of knowledge. Other factors like politics (respondents 2 and 9) also has a massive influence on the municipal water service authorities. The challenge is how to balance politics and technology especially in the smaller and rural municipalities (respondent 7).

5.8.2 Conclusions

The main findings from this section can be summarised as follows:

- South Africa has a unique situation with respect to the spatial layout and that water is not close to its economic centres. Because of urbanisation, innovative ways of overcoming the ever-increasing demand for water are needed. The main solution is posed to be through partnerships, which is complex at best of times.
- Unfortunately, both civil society and business is slow to change their views and ways of dealing with water. A big driving force will be necessary to drive this change.
- Another challenge is that the governance system in WSA is politically run. This may cause a management conflict between technical and political teams when decisions need to be made. This distinction between teams, however, is more prevalent in smaller rural municipalities.
- A lot of attention is required to bring change to organisational environments in order to embed technology, as well as prevent the unnecessary turnover of human capital amidst this change.

CHAPTER 6: DISCUSSION

6.1 Introduction

The primary objective of this research study was to firstly identify current and future factors that play a role in the water industry according to professionals, and secondly to ascertain how water stewardship practises in South Africa could benefit from ICT development and innovation. Sustainable water practises is of vital importance given the current conditions of drought and climate change.

This chapter will interpret the insights from 11 in-depth interviews with regards to current and future factors, as well as ICT implementation. The findings of the data analysis are then triangulated to the research problems and literature review in earlier chapters.

6.2 Research Question 1

6.2.1 Findings

For research question one, the three current factors that held the greatest authority was government and management, public participation and awareness as well as planning and strategy; with all respondents referring to these factors.

The importance of these three factors cannot be ignored in the current state of South Africa's water industry, as professionals in this industry believes that change with regards to these three factors will make the biggest difference. Linking these three factors to positive or negative ratings, showed that government and management in addition to planning and strategy had negative ratings of over 90 percent. Respondents spoke more positively of public participation and awareness, with a 56 percent negative rating, but as mentioned in the results section, work environments spoke mostly about their individual efforts around promoting public participation. Even though this is the case, a lot of room for improvement can be made in the public awareness division.

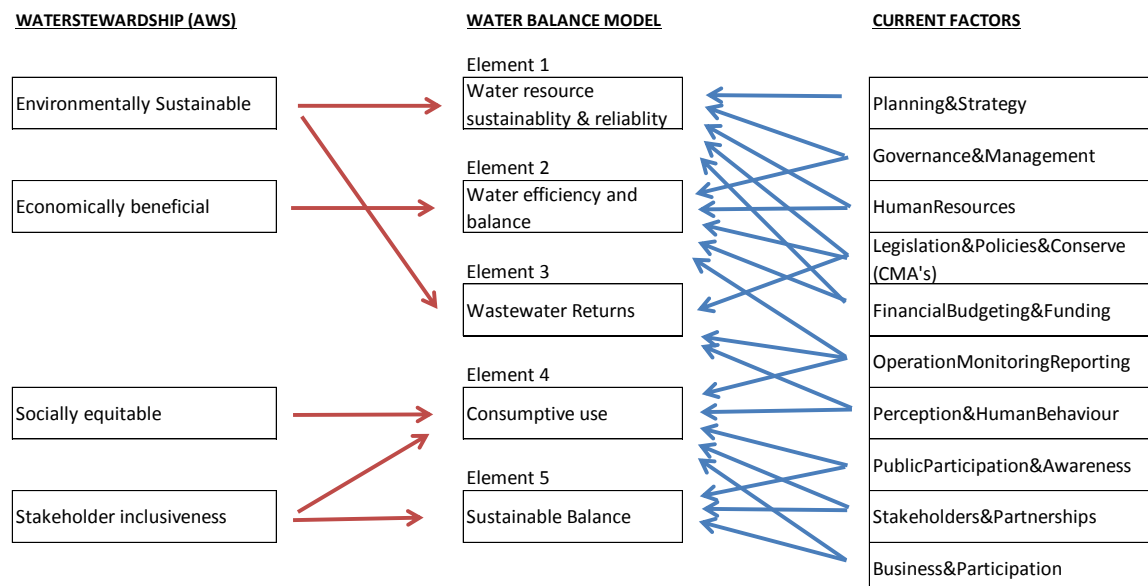
6.2.2 Discussion

Orr and Sarni (2015) stressed the importance of understanding external conditions that plays into the risks that accompanies business in order to respond to it as

effective water stewards. Thus, to understand water stewardship practice, we have to understand the influence that the various role players in the environment of WSAs occupy. The perspectives of each of these role-players may provide valuable insight into what change should occur in the ambition to obtain sustainable water practices. These role-players and stakeholders that were interviewed included DWS, NGO's, private sector, water boards and research institutions. From these interviews, certain factors that currently play a pivotal role in sustainable water practices stood out above the rest. The overall top ten factors discussed by the groups were identified by calculating the amount of times that it was mentioned, followed by the cumulative amount of time respondents talked about each factor.

Rosa et al.(2013) developed a water balance model that was divided into five elements for the purposes of this study, and for the ease of discussion. Figure 7 compares the top ten current factors identified from interviews with this framework. As indicated, the factors can be matched to the respective elements of the framework. Additionally, key factors in the definition of water stewardship, as defined by the AWS, were matched to the water balance model. Research findings are discussed according to this framework.

Figure 7: The water balance model



The three highest scoring current factors will be discussed according to elements they feature in. For governance and management, that will be in element one and

two, and for planning and strategy, element one. Public participation and awareness will play the biggest role in element four and five.

Element 1: Water resource sustainable and reliable.

Medema et al. (2008) highlights the level of complexity of natural resource use processes and dynamics. Managing our water resources in a sustainable way forms the basis of water stewardship, thus the first element in the water balance model is accredited to environmentally sustainable practices. Essentially it assesses the external risks and stresses that may jeopardize the ecosystem. It then evaluates whether future infrastructure and policies are in place to protect the ecosystem.

Environmental sustainability was linked to five current factors. These factors include planning and strategy, governance and management, human resources, legislation and conservation policies as well as financial factors.

One of the key findings iterated by NGO's, water boards and research institutions was the contrasts between the government and environmental approach to water resource management. Other identified problems with regards to water resource management included a visible lack in appropriate skill, lack in planning and decision making as well as a lack in compliance and regulation. Planning capabilities was questioned by respondents 3 and 11, referring to the current crisis with regards to the draught, and the lack of planning preparing us for it. The consumptive nature of the planning that is done was highlighted by respondent 2. One respondent was of opinion that our planning lacks nothing, but the implementation thereof is the problem (respondent 10). In the long term, these factors can have a detrimental effect on water sustainability.

The above outcomes are supported in a study by Wegelin and Jacobs (2012). They found that the implementation of water conservation and water demand management at WSA level have been inadequate for many years. Too often, South African municipalities have no water resource management strategy or plan in place, or if one can be found, it is often vague and unspecific (respondent 1). Very similar to the factors identified by the respondents that were interviewed, Wegelin and Jacobs (2012) attributes this lack of planning to lack of financial, technical and institutional capacity to support such strategy or plans.

One of the reasons that may explain the identified problems might be that the management of water was decentralised and authority was given to local municipalities (respondent 1,2 and 4). These municipalities could not live up to expectations around planning and regulation. In addition to this, budgeting and funding in the municipal hierarchy was also decentralised, requiring local municipalities to take charge of their own budgets. The acquisition of funding comes mostly from local sales of electricity and water. This revenue generated from sales then has to be divided between many departments within the municipality (respondent 11). This often leaves a void in revenue available for water resource management. Pietersen et al. (2012) discussed the lack of cross sector policy coordination and implementation in the management practices of water resources. As was highlighted by the respondents in this study, Pietersen and his peers agreed that weakness in institutional capacity, legislation and regulation are deterrents to resource sustainability.

On the other hand, both the private sector and DWS stressed the importance of human capital (respondents 5, 8 and 11). It was professed to be an essential component to drive water stewardship and to uphold governance and management, and also to enforcement and improve operation and efficiencies. The biggest reason for the deficit in human capital was attributed to lack of budgeting and insufficient funding.

Element 2: Water efficiency and balancing.

The second element extrapolates on the roles of WSAs, how efficiently they manage water as a resource, as well as maintenance and effective management of the infrastructure associated with the water industry. In short, element two assesses ways to balance consumptive use. Aspects such as the operation of infrastructure, and cost efficiencies are considered.

A big overlap was found between the current factors that could be linked to element one and element two. The only exception that was found was that planning and strategy was replaced by operation monitoring and reporting. The results show that operation efficiency and reporting was mentioned as a current factor by all the working environments except for the DWS. The assumption could be made that it would be an important factor across all the working sectors in the environment of

WSAs. Although DWS did not extrapolate on operational efficiency, it was made clear that they are only the custodian of water services and water resources, but that the responsibility and the authority of water management are accredited to the WSAs.

Thus said, the DWS does feel a sense of frustration with regards to this authority given to municipalities, since they are blamed for many bad decisions (or no decisions) made by the municipalities. According to the DWS there is a fake confidence in that the municipalities have the capacity to ensure that “there are financial resources, planning, operation and maintenance, and the like” (respondent 11). The problem arises with authority and funding being decentralised and given to numerous municipalities who have to make due with what they have. According to a study that was conducted on 11 countries, including South Africa, institutional changes like decentralization in the water sector itself occurs as a result of two factors (Saleth, 2000). The first, endogenous factors, includes aspects such as water scarcity, performance deterioration and financial viability. The second, exogenous factors, comprises of factors such as political reform, natural calamities and progress in technology. The study concludes that prioritising sub-sectors (like the municipalities) can have a positive influence on the water sector, but currently this decentralisation is not perceived as the solution by the interviewed respondents.

The municipal hierarchy is not the only concern however. Another operational management problem is that of infrastructure. Various respondents from research institutions and water boards highlighted the issue of a degrading infrastructure, and leaks amounting to large revenue losses. One of the respondents from the research institutions mentioned that only about five percent of the infrastructure functions optimally. Another respondent emphasized that up to 35% of the country’s water usage are lost due to faulty infrastructure; this value was calculated using only about 50% of data, since data gathering in itself is sub-standard. The other 50% of data used are based on estimates (respondent 9). Hedden and Cilliers (2014) confirms this in their study. This has huge repercussions for sustainability (Carden & Armitage, 2013).

Some other reasons provided for poor water efficiency are lack of information, poor financial budget allocation, weak collaboration with stakeholders, urbanisation,

difficulty to control polluting industries and politics. To worsen the problem, South Africa is not only classified as one of the most arid countries in the world but also has water demand that already exceeded the environmental reliable yield (Department of Water Affairs and Forestry (DWA), 2013; Wegelin & Jacobs, 2012).

The results correspond with the findings of Meissner (2016); although the National Water Research Strategy Report – second edition (NWRS2) prioritises issues with respect to the environment and equity, the ontological complexity thereof is downplayed. This begs the question whether the epistemological complexity thereof was considered during the drafting of the NWRS2 (Wayland, 2015). Many parties feel disconnected from the strategy and do not see themselves as a part thereof as they weren't included in the submission to DWS while drafting the NWRS. Thus, both the NWRS and the DWS has low agential power. Meissner (2016) continues to say that water governance is not just about the interactive relationships between role-players in making decisions and solving problems, but also about how people perceive the water governance landscape. The dominance of paradigms and theories often hamper innovation.

As could be expected, revenue was identified as a major factor in infrastructure upkeep and management. According to Ruiters (2013), South Africa has a severe backlog in investments into the water infrastructure. This under-investment has been estimated to be more than R600 billion by 2011. Some of the explanations for this may include the insufficient revenue allocation as referred to earlier, as well as a lack in the required skill sets to overcome financial barriers.

The irony to the financial problem is that WSAs often complain that they do not have sufficient funding, whilst most financial institutions say they can't find bankable projects as a result of poor applications and strategies in water projects (Wegelin & Jacobs, 2012).

Element 3: Wastewater Returns.

The third element of the water balance model focus' on reliable treatment of waste returns. Providing trustworthy and affordable wastewater treatment plants however, as stipulated in a paper by Massoud, Tarhini and Nasr (2009), is difficult in many parts of the world, especially in developing countries. In a municipal environment

this typically relates to sewer and waste water. Reliability usually goes hand in hand with regular sampling and analyses to ensure compliance. Three current factors were associated with reliable wastewater treatment including legislation and policies, operation monitoring and reporting as well as perceptions.

According to respondent 7 from the private sector, not enough is done to ensure that legislation and policies are adhered to. The municipalities themselves are often not compliant with the legislations. One of the reasons that they cannot comply, is the fact that the existing infrastructure is placed under exceedingly more pressure as urbanisation occurs (respondent 5 and 10).

Massoud, Tarhini and Nasr (2009) states that developing countries lack not only the funding to construct big centralised wastewater facilities, but they also lack the technical expertise for management and operation of these facilities. Three out the four respondents from WBs agreed with this by stating that the required skill set to run and maintain water treatment plants are in short supply. In addition, respondents from DWS and NGO's mentioned challenges in the remoteness and spatial layout in some areas of our country, especially in rural areas, complicating the infrastructure in such areas. Chan, Yeong Wu, Juan and Teh (2011) acknowledges this problem stating that as legislations around wastewater have become stricter, wastewater treatment in rural areas have become an increasing concern.

One respondent from a water board stated that there has been interest from the mining sector in reusing water from wastewater plants in their underground processes. This could entail huge opportunities to save potable water, as well as to limit more pollution, but this respondent says that the wastewater plants we have running cannot clean the water to a sufficient level for reuse by the mines. Identifying and consequently improving problems in these areas can have a big influence on our water footprint.

Lastly, altered perceptions around waste-water reuse are necessary. Except for the false perceptions around the quantities of water that are used by households daily, many individuals also question the safety in the re-use of water.

Element 4 – Consumer

In the case of WSAs, this element refers to the amount of water that could be returned to nature and the communities. This element addresses the public education and awareness projects. The fourth element was attributed to current factors including operation, monitoring, reporting, human behaviour and perception, public's participation and awareness, business participation as well as stakeholder partnerships.

In order to achieve a sustainable water balance, the volume of water that is used should be either returned to the environment after it is treated or the implementation of community projects that produce volumetric water savings benefits equal or greater than the volume that has been consumed (Rozza et al., 2013).

Respondents from research institutions and water boards referred to issues of leaks and how it amounts to large revenue losses as well as the effect on environmental sustainability. Respondents 2 and 8 warn that equity in water distribution has still not realised. Another factor commonly mentioned amongst the respective working environments was the unawareness and uninformed perception of the public with regards to the scarcity of water. The reason for the civil sector not being acquiescing to government could be that this sector was not properly consulted in the drafting of the NWRS. This lack of consultation might be due to the administrative strain that interviewing this sector would place on the DWS.

Meissner (2016) proposes that if government and WSAs wants to improve on their governing capacity it has to widen its network of collaboration. Both respondents from NGO's highlighted that finding solutions to difficulties in water stewardship practices strongly depends on the active involvement of stakeholders, but that working with stakeholders can be challenging. To enable this participation from stakeholders, the inherent motivation for their involvement will have to be identified (respondent 6).

Not only stakeholder participation, however, was deemed an essential role-player to improve practices, but both public and business participation was identified as vital current factors by respondents in water boards. As concluded in a study by

Dungumaro and Madulu (2003), public involvement is deemed fundamental in the efforts to attain successful and integrated water resource management (IWRM) practices. Public participation with regards to everything from logging complaints, providing an extended view into leaks and other infrastructure problems, as well as helping to save water will play a pivotal assistive role (respondent 1). Respondent 6 talked about the importance of civil society with regards to their influence sphere in constitutional rights. They also stated that South Africa as a whole is willing to engage communities, making this process easier.

The NGO's highlighted that big businesses often have a consumer mentality when it comes to water usage (respondent 2), justifying polluting and overuse by the fact that the water-use and penalties are being paid for (respondent 6). According to respondents from the water boards, the power-complex of big businesses makes it difficult to reason with them with regards to cost of waste water and the penalties associated with it. These companies will often threaten to up and leave, resulting in devastating revenue and job losses. According to a study by Lambooy (2011), "the majority of the 100 world's leading companies in water-intensive industries still have weak management and disclosures of water-related risks and opportunities" (p.852). Her statement was reinforced by a respondent from the NGO working environment, stating that even though South Africa is amidst a water crisis, water dependant industries are still not disclosing their water footprint. A massive opportunity for saving potable water would be to resell used water to, for example, the mining sector. Municipal processes, however, are insufficient to offer mines this opportunity, hence potable water is lost (respondent 1).

On the positive side, respondents from research institutions mentioned the move towards corporate social responsibility in large corporate sectors. This entails the measurement of their water footprint, which in the long haul, may deem some positive overall results (respondent 9). Large companies also monitors water quality as part of planning for water processes that needs to occur on site, a good example of this is in the mining sector. This gives municipalities free access to water quality data sets which could be used to improve their own operations.

6.2.3 Conclusion

Element five of the sustainable water balance framework acts as a conclusion for research question one. It ensures that the best quantifiable and sustainable balance is achieved between the resource, operating efficiency, wastewater returns and consumptive use. According to Rozza et al.(2013) this is only possible through building relationships between the business, communities, industries, municipalities, government, research institutions, NGO's and water associations.

Based on the discussion of the first four elements of the framework, ATLAS.ti was used to create a network view to help find connections between the main topics and the current factors. This network view is displayed in Appendix 13. The diagram provides information around the connectedness of various topics and current factors. The aim of water sustainability is to obtain a positive balance in various areas of concern, but as highlighted in this paper, negative factors also play a role in many of these areas. These positive and negative factors that affect a sustainable water balance are set out below.

Factors that supports a positive water sustainable balance:

- **Collaboration** between various stakeholders and role players could deliver valuable data that supports better **planning and strategy** yielding a more sustainable water balance. An improved collaboration would depend on the **participation** and partnerships of stakeholders, **business and the public sectors**.
- Better data and improved planning and strategy will positively affect **governance and management**. Other factors that play a direct role in the quality of governance and management include professional skill levels and funding availability.

Factors that negatively influence water sustainable water balance:

- Poor **governance and management** is fed by many negative streams. Some of these streams include poor planning, lack of adaptability, poor implementation strategies, poor data and decentralisation of authority and finance.

- A big negative influence on water sustainability has been identified as the loss of water. Water losses are a consequence of many concurrent factors including **poor operation and maintenance, finances** and **inadequate infrastructure**.
- **Poor compliance monitoring** also affects the water sustainability balance negatively. Aspects that play a role in poor **compliance monitoring** include poor sampling methods, poor awareness around legislation and policies with regards to compliance, as well as a lack of pollution monitoring. The civil sector's ignorance around pollution is the defining factor in adherence to pollution control.
- **Bureaucracy** in management systems as well as a **lack of budgeting and funding** was often seen to have a negative impact on attracting and attaining employees with the necessary **skill level**.

The top three current factors were again emphasised during the set-up of the network view. It can be deduced that governance and management, public participation and awareness as well as planning and strategy forms the foundation of all identified current factors for research question 1.

6.3 Research Question 2

6.3.1 Findings

The main outcome of research question 1 highlights the current situation and predicament that many WSA's face on daily basis. We could ask the question that Frederick Taylor asked, what is "the one best way" (Mintzberg, 1994b) out of this dilemma? For strategists like Frederick Taylor it is important to think about what factors would allow the organisation to become more efficient and resourceful at achieving its goals.

Schmidt (2015) proposes that existing government and WSAs frameworks consist out of three functional components: policy, planning and intelligence. Though all three are applied to help make decisions within environment of WSA's, it can't predict what lies ahead. Many alternative methodologies exist to help foretell alternative futures like scenario planning and Horizon model (Shakweer & Youssef,

2007; Wayland, 2015) amongst others. The one thing these tools have in common is foresight. Schmidt (2015) defines foresight as a discipline that identifies and examines weak signals that provides context for predictive analysis and planning.

Respondents provided insight as to what factors they perceived are relevant components that are necessary to become better stewards of water in the future. Technology and products were perceived as the most important future factor. Trust and accountability was identified as the second most talked about future factor, with nine percent of total share of voice spent on this factor. Thirdly, public participation and awareness, as was identified during current factors, again featured as one of the top three future factors.

6.3.2 Discussion

The top ten most important future factors were discussed under each of the elements of the water balance framework, similarly to what was done for current factors.

Element 1: Water resource sustainable and reliable.

Gleick (1998) paints a very bleak picture on water sustainability if no changes are made to ensure water availability in the near future. These decisions will have to be made on the level of element one first, conserving and protecting the resource that we have. Some of the decisions that will have to be made have been highlighted by respondents from the DWS and NGO working environments. They mentioned the implementation of appropriate technology on public housing level that, for example, could allow for lower water consumption. These technologies might include hardware like low flow taps and small water reuse systems. According to these sectors, the reuse of grey water is especially important to be more sustainable.

Another concern that was highlighted by respondent 11 was that of climate change. Amidst climate change and global warming, water as a resource may soon become more of a crisis than is anticipated. Flooding was also emphasized as a very viable concern with respect to climate-change, and with this comes the responsibility of disaster management and water catchment should the opportunities arise.

Smit and Pilifosova (2003) states that: "Adaptation to climate change has the potential to substantially reduce many of the adverse impacts of climate change and

enhance beneficial impacts though neither without cost nor without leaving residual damage” (p. 9). This will have to be considered as an important future factor if we want to ensure future water availability.

Part of this adaptation could be implementation of information systems as was suggested by the respondents from the NGO working environment. Nationwide water information systems will give access to data for planning at catchment level, improving water volumes to commence with. Respondent 9 adds to this by stating the plans should be adapting in nature, so that the plans can change as our environment changes. Gleick (1998) states that “traditional long-term planning has relied on the use of scenario development” (p.205), but according to respondents in this study implementation of information systems will provide data so that there is less estimation, and more value to planning.

Element 2: Water efficiency and balancing.

The future water efficiency of South Africa depends on a number of factors. Respondents from NGO’s, water boards and research institutes points out that we are often nervous about new technologies that has not been applied by WSAs before. Reasons for this could include a lack in the expertise needed to run new technological systems, as well as the experience of previous lower-level technologies failing due to poor quality (respondent 8).

Since maintenance is considered a large current deficiency in the water infrastructure, it was sure to play a fundamental role as a future factor as well. Difficult decisions needs to be made with regards to spending revenue on maintaining old infrastructure, or applying it to building new vital infrastructure (respondent 7). The same conundrum comes into play when decisions need to be made with regards to buying, for example, many conventional water meters, or a few new technologically smart meters (respondent 9). Briscoe (1999) conducted a study on how water infrastructure financing are changing in developing countries, and stated that infrastructure financing accounts for more or less 50 percent of government spending in developing countries. This obviously places a tremendous amount of strain on the civil society, investment is lacking and performance of the

investments is unsatisfactory. One possible solution might be one similar to what we have seen happening in the electricity sector. Respondent 2 from the NGO working sector stated that: "local governments realised that actually smaller local level of better generation is the way to go", indicating that not every section of the civil sector needs to be treated under the bulk infrastructure as it is currently provided. This could entail water tanks or small water treatment systems in the water industry similarly to which solar panels have been used in the electricity sector.

Funds do not only come into play with the choice of conventional versus new technology, but also in the choice of human capital. Bronzini and Piselli (2009) describes the importance of human capital in especially the measure of productivity. Young professionals with the technical experience need higher compensation than those who do not have the technical know-how. These young professionals also have no authority in the work-place, and thus obtaining a viable workforce becomes difficult (respondent 10). As a future factor this then entails finding new methodologies or ways of compensation to employ those individuals who can truly make a difference in the water industry.

The hierarchy of municipalities and their decision making were also discussed as an important future factor. Decisions made with more data available, and by more role-players involved, will be better decisions according to respondent 5.

Element 3: Wastewater Returns.

The potential reuse of water was emphasised by the water boards, suggesting that previously used water could be used in the mining and agricultural sectors specifically. They continue by stating that the current wastewater treatment plants do not allow for cleaning water to the required levels for reuse, and thus a lot of usable water is lost. Aspects of improvement can thus include the building and improvement of wastewater treatment plants so that water losses are restrained. Respondent 3 claimed that the engineering sector in South Africa is very capable of doing just this, but that the implementation of such plans and the actual managing thereof is left wanting. Instead of building high cost wastewater treatment plants, constructed wetlands have been proven to be efficient technology for wastewater treatment (Kivaisi, 2001). These wetlands are low cost, easy to operate and maintain, as well as have a strong potential for application in developing countries

according to Kivaisi. Respondents from the NGO's reiterated this possibility and suggested wetlands as treatment in rural areas especially, "not flushing everything into the wastewater treatment works as much and as quick as we can".

Monitoring pollution compliance and reporting by both the industrial and civil sectors will also make headway to productive water stewardship practices. According to Rajaram & Das (2008) countries around the world are struggling to find an effective regulatory regime that can control the expulsion of industrial effluents into sensitive ecosystems. Although this study suggests that the strict implementation of ecosystem specific discharge standards is the solution to the pollution problem, respondents in this study suggested ICT as a viable method to employ in the encampment of pollution. It is suggested that implementation of this technology will assist municipalities in monitoring pollution levels, and thus inhibiting it.

Element 4 – Consumer

Public awareness and participation have been identified as a future factor in water conservation efforts. Water management by communities have become popular throughout sub-Saharan Africa, but diminished water sustainability indicates that this practice is not ideal (Harvey & Reed, 2006). Harvey and Reed suggests that a differentiation must be made between community participation, and community management, with the first being a prerequisite for water sustainability. Respondents from the NGO group was of opinion that educating the public sector in water conservation and establishing awareness of the fact that South Africa is a water scarce country will go a long way. Willis et al. (2011) conducted a study into the link between environmental and water conservation attitudes and perceptions and quantities of water consumption. The results of this study indicated that residents in households who had very positive environmental and water conservation attitudes used significantly less water, indicating that education will play an essential role with regards to water conservation. Respondent 11 continued this conversation by stating that these education and awareness campaigns must be conducted on a level that will be understood by the general public.

A World Summit on Sustainable Development was held in Johannesburg in 2002, and at this summit Integrated Water Resource Management (IWRM) was defined as "a process, which promotes the coordinated development and management of

water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (Rahaman & Varis, 2005, p. 15). It was emphasized that water as a resource should be managed under the values of good governance and public participation (Rahaman & Varis, 2005). In the opinion respondents 2 and 6, partnerships with the business and the private sectors are essential for funding technologies and innovation.

Some references were made by the water board to the possibility of future privatization of the water industry, and the challenges that would be faced in the case that this ever happened. Per respondent 1, privately run companies might seem as if it runs more effectively, but since water is a national asset, privatization of the water industry is unlikely to happen in South Africa. As per Rahaman and Varis (2005), some critics fear that privatization may encourage fragmentation. This study also underscores that privatization in countries where basic infrastructure is not yet fully established; full cost recovery application might not be ethical or practical.

Respondent 11 noted that trust and accountability is of utmost importance in water governance and management, especially with regards to free water. For this reason government should carefully consider their promises to the public and the potential impact it could have if service were to be undelivered.

6.3.3 Conclusion

As was used for the conclusion of current factors, element five will again be used in discussing the conclusion to research question 2. This element combines all the positive and negative factors that might have an influence on obtaining a sustainable balance in future. A network view was developed using ATLAS.ti to find connections between the main topics and the future factors. The final diagram is provided in Appendix 14. The diagram conveys information around factors that may influence water sustainability positively or negatively.

Factors that has a positive effect on water sustainable balance:

- Adaptability in **planning and strategy** was perceived as a positive influence on a sustainable water balance. This includes having access to quality data to enhance adapting to climate change.
- Implementation of **technology** offers many solutions including basic, off-grid and green technologies. These will provide more sustainable solutions to achieve an improved water sustainable balance.
- According to respondents, **sustainable water solutions** will be found by including many aspects; including education, ICT, other technology and products and reusing water amongst other factors.
- To achieve good **compliance monitoring**, the correct **expertise** within the WSAs, ICT and a firm knowledge of discharge limits will prove valuable information. Good compliance monitoring in turn will improve the water sustainable balance.

Factors that negatively affect water sustainable balance:

- On the contrary a **lack of technical skill** will negatively affect areas of management, financial planning and general planning and strategy.
- Using estimations instead of actual data will negatively influence the water balance due to the lack of **transparency and accountability**.
- The **mind-set** on existing conventional technology was seen as a prohibiting factor in finding new sustainable solutions.
- The effect of **global warming** and climate change was perceived as an important factor to consider, especially since it could have a major impact on the water sustainable balance. Proper planning and strategy with regards to adaptation to change will have to be put in place where global warming is concerned. Public awareness of climate change will have to be altered to allow for sustainable solutions.

6.4 Research Question 3 and the Complexity Theory

6.4.1 Findings

Sixty percent of remarks with respect to ICT obtained positive reaction while the remaining 40% was allocated to challenges.

Some of the most important factors that were identified that will count in the favour of ICT were found to be real-time data, eliminating (human) errors, holistic view of data, facilitate behaviour change, support better planning as well as to connect stakeholder for participation and collaboration.

Some of the challenges that were identified included financial burdens with respect to investment, human resources both with regards to job-retention as well as the training and the operation cost with regards to data and maintenance costs that will have to be made in this regard.

6.4.2 Discussion

To better understand the complexities of the environment of WSAs, the interviews were analysed to identify factors that have a strong influence on this environment. Identified factors included aspects such as the remoteness and spatial layout of communities, strong perceptions with regards to water usage, politics in technical decision making, high-turnover of human capital, as well as the hampered implementation of technology in WSA's. These factors are all typical examples of ontological and epistemological boundaries. Wayland (Wayland, 2015) proposed that these boundaries are known to us, but we should be conscious of the fact that they are continuously evolving.

A reason for the slow implementation of technology could be ascribed to the rigidity of the water management practice. Firstly, this may be related to human behaviour and perceptions. Secondly, even if employees on ground level wanted to implement new technologies, they are often hampered by political interference. Therefore the underlying reasons for the ongoing rigidity may be ascribed to past events. This is best described by Schreyogg, Sydow and Holtmann (2011) stating that 'bygones are rarely bygones' within the theory of path dependency. Even small changes in complex systems can alter the long term behaviour thereof (Brown & Eisenhardt,

1997). Luckily, even amidst a long dark tunnel, there is hope. According to findings by Arthur (1989), the more modern technologies are adopted, the more experience will be gained and the more these technologies will be improved. This may further increase adoption rate.

An important part of these technological adoptions into the water sector would be ICT. Bharadwaj et al. (2013) explained that we have to rethink the way that ICT is aligned with business strategy. According to Drnevich and Croson (2013), IT (or ICT) is integral to decision making in business. Even though the water-utility sector is traditionally seen as an offline business, ICT products like DBS, CPS and Industry 4 offer solutions that could enable better water stewardship. Various other studies have acknowledged that DT disrupts many traditional business practices, but they have identified numerous advantages that DT holds for these business practices (Bradley et al., 2015; Utesheva et al., 2015; Wenzel et al., 2015).

One of the objectives of this study included to gain insight into possible reasons of the lack of ICT adoption in WSAs, while also assessing the preparedness of the WSA to implement such technologies. Table 20 provides a list of the most discussed current and future factors identified by respondents that could influence a sustainable water balance. The views of ICT opportunities and challenges were matched to the identified factors in this table.

Table 19: ICT Opportunities and ICT Challenges matched to the identified factors.

Identified factor	ICT Opportunities (Positives)	ICT Challenges (Negatives)
Planning & Strategy	Provide data for better decision making and planning	Cost of and capacity for data storage
Governance & Management	More control and feedback to govern better	Standalone service - not integrated. One of many other government services.
Operation & Efficiency	Reduce Human Error & intervention Improved data accuracy Improved operational efficiency	Longstanding employees Training Need more technical skill to implement and maintain
Legislation & Policies and Conservation	Improved forecasting & planning Disaster management	

Identified factor	ICT Opportunities (Positives)	ICT Challenges (Negatives)
Regulation & Compliance monitoring	Improved monitoring efficiency	Privacy issues Security issues
Financial budgeting	Provide data for better decision making	Higher capital cost Higher operating cost
Human Resources	New job opportunities	Higher skill level requirements
Collaboration & Partnerships	Platform for communication Innovation Data sharing	
Trust & Accountability	Platform for communication and transparency	
Human behaviour & Perception	Platform to facilitate change	Long payback periods Job losses

Table 19 indicates that, as was seen in the results section, respondents identified more positive than negative aspects around ICT adoption. The identification of the negative aspects does, however, play a vital role. For it is by eliminating these aspects, that ICT will find its way into the water sector.

The major negative aspect around ICT can be described under finance. A lot of capital will be needed during the implementation phase, and subsequently operating cost for this system will have to be carried by some entity. Finances will also be needed for employment of a work-force with the necessary skill-sets, or for training those individuals who are already on-board. Additional financial provision will have to be made for elementary aspects such as data storage and telecommunication costs. Respondents are also worried about the pay-back duration, which may place strain on municipal budgets. Respondent 4 agreed with Schmidt (2015) who states, the endless succession of near-term emergencies often diverts from longer term investments.

The finances for complex ICT systems will have to be provided from somewhere. The cost of water carries most of the current financial needs in the water sector. Government gives cash injections during emergencies as well as to help train individuals who can then be placed in water departments of municipalities. It is not foreseen that government will provide revenue for investment in ICT. Since the cost of water in South Africa is still relatively low, increases in this aspect may cover

some of the revenue needed for implementation. Other avenues for revenue could include public-private partnerships (PPP) for specific projects. Inherent motivation arises as a concern when talking about PPPs, due to the fact that businesses will not want to become involved in a government sector if there is no return on investment (Respondent 6). Privatization is the only other identified revenue avenue. The probability of water sector privatization in South Africa is very low due to the fact that water is a national asset. This avenue will most likely not yield any fruit. Thus said, possibly more than 35% of South Africa's water is currently lost due to poor infrastructure and management (respondent 9). If this water was not lost, and actually paid for, this could not only reduce our water footprint, but it would bring us a long way towards funding ICT.

Privacy in all technology is becoming a world-wide concern, as will be privacy with the implementation of ICT in the water sector (respondent 10 and 11). Hacking into the technology could have detrimental effects; water-supply could be cut off, data security could be compromised or water could be wasted due to the integrated nature of the system.

Perceptions in communities around ICT will also need to be altered. In a country with unemployment rate of almost 35% the fear of losing jobs is real (Statistics South Africa, 2014). Whole households depend on sole working individuals, and wrong perceptions around technology implementation, even at management level, may halt the implementation thereof.

The question of whether the positive identified aspects around ICT can facilitate a migration of the negative aspects comes to mind. As Arthur (Arthur, 1989; Schreyogg et al., 2011; Sydow, Schreyogg, & Koch, 2009) suggests, the first steps in application of ICT can facilitate the complete adoption thereof. Since the experts in the environment of WSAs could identify numerous positive aspects around the prospects of ICT in the water sector, this could be the start of a new era. One of the biggest positive aspects around ICT implementation is the platform it provides for data sharing, communication and partnerships. This allows for stakeholder, public and business participation in the initiative towards sustainable water practices. Human behavioural change depends on the establishment of this platform.

6.5 Overall Analysis and Conclusion

The Cynefin framework provides a convenient method of structuring the identified current and future factors and the acknowledged challenges and opportunities around ICT into five domains. As discussed during the literature review, the domains consist out of a known, knowable, complex, chaos and disorder.

In the current state of South Africa's water sector, many problems are known. The known sector on the Cynefin framework is identified by repeatable cause and effect relations and standard operating procedures. The decision model in this domain is a sense-categorise-respond according to predetermined practice. Identifying these problems allows for the identification of the solutions. The top factors described by respondents that fits into the known domain includes infrastructure, governance and management, legislation and policies as well as finance. All of the problems that can be associated with these factors in reality have a solution. According to the Kurtz and Snowden (2003) who developed the Cynefin domain, "structured techniques are not only desirable but mandatory in this space" (p.468). This indicates that problems in this domain are unnecessary, and should have been taken care of timeously. The unfortunate state of affairs is that these have been identified as some of the biggest causes of frustration in the WSA environment.

The next domain entails knowable causes and effects. These factors may be partially known or known by a specific group of people. It is characterized by cause and effect that is separated over time and space; it entails scenario planning and systems thinking. The decision model entails sense-analyse-respond. Planning and strategy, for example, falls into this domain, as do human resources, conservation, operation and monitoring as well as public perceptions. Problems in these areas do not always have set solutions, but with analysing and research, solutions can be found. These factors can be moved from the knowable to the known domain, but this requires time, resources and expert opinion.

In the complex domain, many of the factors that were discussed under the complexity of systems in chapter 5 resurfaces. In the complex domain, patterns in situations need to be identified in order to find a solution. Perspectives come into play, where different role-players would identify different solutions to the same

problem. The decision model here involves probe-sense-respond, due to the fact that information often needs to be gathered post piloting. For the purposes of this study, human behaviour across sectors falls into this category. Stakeholders and partnerships as well as business and public participation involve complex problems with no linear solution. Agendas and inherent motivations for partnerships needs to be evaluated and understood before solutions can be developed.

The fourth domain is that of chaos. In this domain no cause and effect relationships can be perceived and there is little to analyse. The decision model is based on act-sense-respond, often acting on crises without methodology or a systematic approach. Some concerns in this domain include climate change, draught and flooding.

In conclusion, many identified current and future factors fall in the known and knowable domains. Pertaining to the top three current factors identified; governance and management falls into the known domain, meaning solutions to this identified problem can easily be found. ICT can provide quicker feedback regarding operations, resource administration, and many other areas that will ease the process of management. Planning and strategy falls into the knowable domain, thus some research will have to be conducted in the process of finding solutions, but ICT will be able to assist in this endeavour. Finally, public participation and awareness falls into the complex domain, ICT can provide a communication platform that will allow cooperation of civil society with the water industry.

Public participation and awareness was also deemed one of the top three most important future factors. Trust and accountability also falls into the complex domain, due to the fact that it entails responsibility and accountability of human behaviour. ICT can assist in this regard by providing more transparency. The most important future factor identified was technology and products. This links directly to the importance of implementation of ICT in the water industry. This also refers to the preparedness of professionals in the WSA environment to adopt ICT towards more sustainable water stewardship practices. Most respondents identified more opportunities than challenges in ICT adoption.

CHAPTER 7: CONCLUSION

7.1 Introduction

As discussed in Chapter 1 and 2, South Africa currently exceeds the reliably yield of their water sources. By 2030 it estimated that South Africa will have a 30% gap between water supply and demand (Addams et al., 2009). Water scarcity will not only affect the economy but also have an impact on the most basic needs of civil society. It is thus imperative that we find ways to improve the current situation.

This research set out to find the key components at play in current water stewardship practices within the WSAs environment. It also explored how ICT adoption could help pave the way to improve water stewardship practices.

7.2 Findings

In research question one, thirty factors were identified by respondents as components that are relevant in current water stewardship practices. Nine out of the top ten factors were predominately perceived as negative, and only stakeholders and partnerships received 52% positive remarks. Not one positive statement was made with regards to perception and human behaviour. All respondents identified planning and strategy as a significant factor that needs to be addressed as soon as possible, in fact, this was the current factor most talked about. Thus said, very few elaborated on the topic. Frederic Taylor (Mintzberg, 1994b) stated that resourceful systems cannot be obtained in the absence of proper planning. The respondents showed a lack of insight with regards to strategy, even though they could identify the lack of strategy, none of them offered any possible solutions for this immensely important factor. This begs the question whether there is really a common goal with regards to the future of water in this country.

The second most identified current factor in the water industry was governance and management, and thirdly, public participation and awareness. Both of these factors were discussed by 100 percent of the respondents.

For research question two, twenty future factors were recognised that could transform water providers into better water stewards, of which the top ten were

discussed. Technology and products was the most discussed future factor, with nine out of 11 respondents acknowledging this factor as imperative in the future of water stewardship. The fact that respondents identified technology and products as the number one aspect that needs to be considered in future, builds an expectation around the possibilities of ICT implementation in the water sector. The only future factor that corresponded with the top three current factors, were public participation and awareness. This was the second most discussed topic as a future factor, and respondents obviously feels that perceptions and participation in civil society needs to change. The third most identified future factor was trust and accountability, mostly with regards to government organisations. Trust will need to be earned by management and governing systems.

One of the biggest concerns is the shortage of time that was spent talking about future factors, in comparison to current factors. This show the respondents can easily identify current factors that needs to change in the industry, but has greater difficulty identifying factors that could lead to change. This is supported by Figure 4, the overall 'share of voice' chart, showing that future factors gained the least amount of time when compared other themes.

The third research question, handling on the perceptions around the possibility of ICT implementation, obtained the only majority positive reaction. Sixty percent of remarks were discussed in the light of opportunities around ICT, with the remaining 40% challenges. ICT was identified as a solution to some of the top current challenges recognized. The most significant identified challenges in the area of ICT implementation were finances, privacy and perception with regards to human resources.

During the introduction to this study, it was anticipated that certain factors would come to light during the interviews with respondents. The identification of these factors could pave the way to ICT implementation. Many of these factors were indeed identified by respondents to a more or lesser degree. Interviewed respondents did display foresight and a readiness into the use of ICT in water stewardship practices.

According to the cynefin model, various current and future factors could be classified into the "known" domain. Implementation of ICT to known factors may be

able to simplify solutions. Application of ICT to knowable factors can cause a migration of these factors into the known domain.

The reality of identified challenges in the implementation of technology in the water sector cannot, however, be ignored. The biggest challenges that were identified can all be discussed under the heading of finances. Implementation and running costs, as well as cost of training, salaries, telecommunications and maintenance all came under scrutiny. Nine out of the 11 respondents recognised this hurdle to the implementation of ICT. The second and third highest hurdles identified included privacy and security as well as the skill level that will be needed in the running of ICT systems.

7.3 Limitations of the research

In essence qualitative research does not seek to control variables as is the case with quantitative research, but rather studies are open ended. Studies of a quantitative nature seek out the currently unidentified factors within the experience of the respondents. For this reason it is often subject to the subjectivity of both the respondents and interviewer. Some limitations that result from subjectivity are:

- Though the study acknowledges global trends, it is limited to the South African environment and context. Therefore a geographical bias and limitation might be present.
- A broad range of stakeholders from various working environments were engaged. The WSA environment was divided into working sectors (for example the NGO's), and the findings of these sectors were grouped and discussed together since they agreed on many of the key factors in their environment (probably as a result of homogeneity). This does not, however, reflect the opinions of the whole working environment as a population, and the answers from a specific working sector cannot be generalised to the whole working sector population.
- Though every effort was made to limit the impact and biases in language during the interviews and piloting, the interviewer is not expertly trained in interviewing and this could have had an impact on the results. The

researcher's bias and reflexivity as well as his role in the environment could have had an effect on the study.

- The sample selected consisted of senior managers, professionals and experts in the environment of WSA. Since the respondents in this study had a good overview of the environment of WSA, it was not deemed necessary to include managers at local municipality levels.

7.4 Recommendations

From a corporate social responsibility perspective, the findings of this study provide companies with insight into the dichotomies in current practices, political connections that might be at play with regards to WSA's as well as the relationships between the intricacies of identified factors and implementation of ICT. These insights present companies with a holistic view about the current environment of WSAs. It may help companies to evaluate water related risks on business in pursuit of longevity of the firm. New corporate water stewardship strategies will improve the sustainability, transparency, efficiency and economics of different water resources. It may also develop collaboration, partnerships and community participation in a joint effort to reduce the overall water footprint.

Regulators like the DWS and WSAs could use the findings from this study to gain a clearer understanding based on the view of others in the WSA environment. It may furnish them with valuable insights on the perceptions of various stakeholders and what they deem as critical components and factors to enhance existing water stewardship practices. Using the Cynefin as a sense making tool, regulators could take strategic action by focusing on the known and knowable domains first. Dealing with obvious issues that has solutions primarily, could free the necessary capacity to engage with more complex matters. The findings of this report demonstrate that ICT could provide opportunities that can be used as a tool to resolve and improve water stewardship practices.

As for NGO's and research institutions, which focussed mainly on sustainability and partnerships, a greater focus can be placed on public awareness and participation. It is known that both these sectors are making attempts in this regard, but projects are not advertised properly. Both these sectors are placed in a way to make

valuable differences in this area, and since public awareness and participation was one of the top three identified factors both currently and for future, improvements in this area will be valuable.

7.5 Suggestions for future research

The aim of this study was to understand what lies behind the rate of ICT adoption within the environment of WSAs. However this study did not try to interpret the various identified factors and the social phenomena that are involved. One suggestion for future research may include delving deeper into the identified factors of this research study.

Three other potential areas of research include the culture, specific strategies as well as the operating environments around water stewardship practices.

Culture, especially in a multi-racial country like South-Africa, plays a central role to understanding dynamic working environments. Future research could focus on the numerous perceptions and biases that are at play in the environment of WSAs. Various aspects around situations, attitudes and expectations within different cultures with respect to most of the mentioned and discussed factors of this study could be investigated. This study looked at each factor superficially; future studies could isolate one of the factors, for example skill, and focus on how or why professionals would be attracted to this industry through the lens of contemporary motivational theories.

A second aspect that could be studied is that of planning and strategy. As mentioned, one of the observations of this study was that very few respondents could offer solutions into our WSA's lack of strategic planning. Given global trends such as growing populations, a rising middle class, climate change and tainted water and leaks, concerns have been raised with regards to the lack of planning and strategic decision that is accompanying these trends (Siegel, 2015). Siegel expresses an interest in how we can align ourselves with future trends and prevent depletion of natural water resources in order to prevent potentially terrible environmental consequences. One suggestion was to keep politics out of water decision making, through the instituting of a centralised technocratic regulatory

structure that has power over government ministries. Future studies could investigate how government influences existing national water strategies. A valuable framework that can be used might be that of Rumelt (2011). This framework considers whether the following three elements are addressed: diagnosing the nature of the challenge, design a guiding policy that deals with the challenge and then implement a set of coordinated actions to carry the guiding policy.

Lastly, an area that needs to be studied is that of the operating environments around WSAs. Patterns of behaviour displayed by the consumers, competition, and stakeholders could be analysed in more detail. Studies could implement stewardship theory and resources dependency theory (Daily, Dalton, & Cannella, 2003) and scenario tools such as the Cynefin framework. Studies could investigate how external resources and organizations affect the behaviour of a particular organisation, e.g. WSAs. A research question could be whether or not stakeholder theory really applies where the interest of WSAs is isomorphic with those of consumers.

7.6 Overall Conclusion

This study has identified the top three factors that currently play a role in the WSA environment as planning and strategy, governance and management and finally public participation and awareness. Factors that will play a vital role in the future of the WSA environment have also been identified. These include public participation and awareness, the development of trust and accountability as well as the implementation of technology and products. The latter was mentioned by all 11 interviewed respondents to be the most important factor.

In probing the future preparedness of WSA for the adoption of information and communication technologies, it was found that there was a vastly positive response. Although many hurdles to the adoption of ICT were identified, more opportunities than challenges were acknowledged. WSA can thus be classified as prepared for the implementation of ICT, should solutions be found for some of the impending problems.

CHAPTER 8: REFERENCES

- Addams, L., Boccaletti, G., Kerlin, M., & Stuchtey, M. (2009). *Charting our water future: economic frameworks to inform decision-making*. Retrieved from <http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/charting-our-water-future>
- Arthur, W. B. (1989). Competing Technologies , Increasing Returns , and Lock-In by Historical Events. *The Economic Journal*, 99(394), 116–131. Retrieved from <http://www.jstor.org/stable/2234208>
- Bayoumi, M. (2015). Cyber - Physical Systems: Reality , Dreams , and Fantasy Magdy Bayoumi. In *2015 IEEE Seventh International Conference on Intelligent Computing and Information Systems* (pp. 1–2).
- Beal, C. D., & Flynn, J. (2015). Toward the digital water age: Survey and case studies of Australian water utility smart-metering programs. *Utilities Policy*, 32, 29–37. <http://doi.org/10.1016/j.jup.2014.12.006>
- Beal, & Flynn. (2014). *The 2014 Review of Smart Metering and Intelligent Water Networks in Australia & New Zealand*. Australia, New Zealand. Retrieved from http://www.watefnetwork.co.uk/files/default/resources/ICTs_for_Water_Efficiency_Master_Class/2014AustralasianReviewofS.pdf
- Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. *MIS Quarterly*, 37(2), 471–482. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2742300
- Bradley, J., Loucks, J., Macaulay, J., Noronha, A., & Wade, M. (2015). *Digital Vortex*. Retrieved from http://global-center-digital-business-transformation.imd.org/globalassets/digital_vortex_full-reportv2.pdf
- Briscoe, J. (1999). The Changing Face of Water Infrastructure Financing in Developing Countries. *International Journal of Water Resources Development*, 15(3), 301–308. <http://doi.org/10.1080/07900629948826>
- Bronzini, R., & Piselli, P. (2009). Determinants of long-run regional productivity with geographical spillovers: The role of R&D, human capital and public infrastructure. *Regional Science and Urban Economics*, 39(2), 187–199. <http://doi.org/10.1016/j.regsciurbeco.2008.07.002>
- Brown, S. L., & Eisenhardt, K. M. (1997). The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations. *Administrative Science Quarterly*, 42(1), 1–34. <http://doi.org/10.2307/2393807>
- Carden, K., & Armitage, N. P. (2013). Assessing urban water sustainability in South Africa - not just performance measurement. *Water SA*, 39, 0. Retrieved from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502013000300002&nrm=iso

- Cashman, A., & Ashley, R. (2008). Costing the long-term demand for water sector infrastructure. *Foresight*, 10(3), 9–26. <http://doi.org/10.1108/14636680810883099>
- Chan, S. H. S., Yeong Wu, T., Juan, J. C., & Teh, C. Y. (2011). Recent developments of metal oxide semiconductors as photocatalysts in advanced oxidation processes (AOPs) for treatment of dye waste-water. *Journal of Chemical Technology & Biotechnology*, 86(9), 1130–1158. <http://doi.org/10.1002/jctb.2636>
- Chermack, T. J., & Coons, L. M. (2015). Scenario planning: Pierre Wack's hidden messages. *Futures*, 73, 187–193. <http://doi.org/10.1016/j.futures.2015.08.012>
- Creswell, J. W., & Miller, D. L. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice*, 39(3), 124–130. <http://doi.org/10.1207/s15430421tip3903>
- Daft, R. L. (1983). *Organization theory and design*. Englewood Cliffs, NJ: West Pub. Co.
- Daily, C. M., Dalton, D. R., & Cannella, A. A. (2003). CORPORATE GOVERNANCE: DECADES OF DIALOGUE AND DATA. *Academy of Management Review*, 28(3), 371–382. <http://doi.org/10.5465/AMR.2003.10196703>
- Deloitte. (2012). *Digital disruption - Short fuse, big bang?* Australia. Retrieved from <http://www2.deloitte.com/au/en/pages/building-lucky-country/articles/digital-disruption-harnessing-the-bang.html?id=gx:th:lk:TT13>
- Department of Water Affairs and Forestry (DWAf). (2013). *Strategic Overview of the Water Sector in South Africa*. Retrieved from <http://nepadwatercoe.org/wp-content/uploads/Strategic-Overview-of-the-Water-Sector-in-South-Africa-2013.pdf>
- Drnevich, P. L., & Croson, D. C. (2013). Information Technology and Business Level Strategy: Toward an Integrated Theoretical Perspective. *MIS Quarterly*, 37(2), 483–509.
- Dungumaro, E. W., & Madulu, N. F. (2003). Public participation in integrated water resources management: the case of Tanzania. *Physics and Chemistry of the Earth, Parts A/B/C*, 28(20–27), 1009–1014. <http://doi.org/10.1016/j.pce.2003.08.042>
- Food and Agriculture Organization of the United Nations (FAO) and the World Water Council (WWC). (2015). *Towards a Water and Food Secure future: Critical Perspectives for Policy-makers*.
- Friese, S. (2013). *Approaches to Coding*. Retrieved from <https://www.youtube.com/watch?v=YibqDB0iO-0&feature=youtu.be>
- Friese, S. (2014). *Qualitative data analysis with Atlas.ti*. SAGE Publications, Ltd.
- Friese, S. (2015). *Approaches to Coding with ATLAS.ti*. Retrieved from

<https://www.youtube.com/watch?v=EvcQLhEzP-A&feature=youtu.be>

- Gleick, P. H. (1998). WATER IN CRISIS: PATHS TO SUSTAINABLE WATER USE. *Ecological Applications*, 8(3), 571–579. [http://doi.org/10.1890/1051-0761\(1998\)008\[0571:WICPTS\]2.0.CO;2](http://doi.org/10.1890/1051-0761(1998)008[0571:WICPTS]2.0.CO;2)
- Gorchev, H. G., & Ozolins, G. (2011). WHO guidelines for drinking-water quality. *WHO Chronicle*, 38(3), 104–108. [http://doi.org/10.1016/S1462-0758\(00\)00006-6](http://doi.org/10.1016/S1462-0758(00)00006-6)
- Groenfeldt, D., & Schmidt, J. J. (2013). Ethics and Water Governance. *Ecology and Society*, 18(1), art14. <http://doi.org/10.5751/ES-04629-180114>
- Harvey, P. A., & Reed, R. A. (2006). Community-managed water supplies in Africa: sustainable or dispensable? *Community Development Journal*, 42(3), 365–378. <http://doi.org/10.1093/cdj/bsl001>
- Hedden, S., & Cilliers, J. (2014). Parched prospects: The emerging water crisis in South Africa. *Water Wheel*, 13(6), 42–47. Retrieved from <http://hdl.handle.net/2263/49110>
- Hepworth, N. (2012). Open for business or opening Pandora’s box? A constructive critique of corporate engagement in water policy: An introduction. *Water Alternatives*, 5(3), 543–562.
- Imane, I., Al, A., Ahmad, S., Ballesterio, M., Bezbaroa, S., Cookey, P., ... Xin, H. (2013). *The AWS International Water Stewardship Standard*. (I. Imane, A. Al, S. Ahmad, M. Ballesterio, S. Bezbaroa, P. Cookey, ... H. Xin, Eds.) (Beta). Alliance for Water Stewardship. Retrieved from http://www.allianceforwaterstewardship.org/Beta/AWS/Standard/04_03_2013.pdf
- Jazdi, N. (2014). Cyber physical systems in the context of Industry 4.0. In *2014 IEEE International Conference on Automation, Quality and Testing, Robotics* (pp. 1–4). IEEE. <http://doi.org/10.1109/AQTR.2014.6857843>
- Kapfudzaruwa, F., & Sowman, M. (2009). Is there a role for traditional governance systems in South Africa’s new water management regime? *Water SA*, 35(5), 683–693.
- Kivaisi, A. K. (2001). The potential for constructed wetlands for wastewater treatment and reuse in developing countries: a review. *Ecological Engineering*, 16(4), 545–560. [http://doi.org/10.1016/S0925-8574\(00\)00113-0](http://doi.org/10.1016/S0925-8574(00)00113-0)
- Kurtz, C. F., & Snowden, D. J. (2003). The New Dynamics of Strategy: Sense-making in a Complex-Complicated World. *IBM Systems Journal*, 42(3), 462–483.
- Lambooy, T. (2011). Corporate social responsibility: sustainable water use. *Journal of Cleaner Production*, 19(8), 852–866. <http://doi.org/10.1016/j.jclepro.2010.09.009>

- Lee, E. A. (2008). Cyber Physical Systems: Design Challenges. In *2008 11th IEEE International Symposium on Object and Component-Oriented Real-Time Distributed Computing (ISORC)* (pp. 363–369). IEEE. <http://doi.org/10.1109/ISORC.2008.25>
- Leedy, P., & Ormrod, J. (2001). *Practical research: Planning and design*. Upper Saddle River: Thousand Oaks: SAGE Publications.
- Massoud, M. A., Tarhini, A., & Nasr, J. A. (2009). Decentralized approaches to wastewater treatment and management: Applicability in developing countries. *Journal of Environmental Management*, *90*(1), 652–659. <http://doi.org/10.1016/j.jenvman.2008.07.001>
- May, T., & Perry, B. (2011). *Social Research & Reflexivity*: 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom: SAGE Publications, Ltd. <http://doi.org/10.4135/9781446250372>
- Medema, W., McIntosh, B., & Jeffrey, P. (2008). From Premise to Practice: a Critical Assessment of Integrated Water Resources Management and Adaptive Management Approaches in the Water Sector. *Ecology And Society*, *13*(2), 29. <http://doi.org/29>
- Meissner, R. (2016). Paradigms and theories in water governance: the case of South Africa's National Water Resource Strategy, Second Edition. *Water SA*, *42*(1), 1. <http://doi.org/10.4314/wsa.v42i1.01>
- Mintzberg, H. (1994a). Rethinking strategic planning part I: Pitfalls and fallacies. *Long Range Planning*, *27*(3), 12–21. [http://doi.org/10.1016/0024-6301\(94\)90185-6](http://doi.org/10.1016/0024-6301(94)90185-6)
- Mintzberg, H. (1994b). Rethinking strategic planning part II: New roles for planners. *Long Range Planning*, *27*(3), 22–30. [http://doi.org/10.1016/0024-6301\(94\)90186-4](http://doi.org/10.1016/0024-6301(94)90186-4)
- Morse, J. (1995). The significance of saturation. *Qualitative Health Research*, *5*(2), 147–149.
- Morse, J. (2015). Data were Saturated... *Qualitative Health Research*, *25*(5), 587–588.
- Orr, S., & Sarni, W. (2015). Does the concept of "creating shared value" hold water? *Journal of Business Strategy*, *36*(3), 18–29. <http://doi.org/10.1108/JBS-10-2013-0098>
- Pietersen, K., Holland, M., & Adams, S. (2012). Groundwater governance in South Africa: A status assessment. *Water SA*, *38*(3), 453–461. Retrieved from http://www.scielo.org.za/scielo.php?pid=S1816-79502012000300012&script=sci_arttext&lng=pt
- Rahaman, M., & Varis, O. (2005). Integrated Water Resources Management: Evolution, Prospects and Future Challenges. *Sustainability: Science, Practice & Policy*, *1*(1), 15–21.

- Rajaram, T., & Das, A. (2008). Water pollution by industrial effluents in India: Discharge scenarios and case for participatory ecosystem specific local regulation. *Futures*, *40*(1), 56–69. <http://doi.org/10.1016/j.futures.2007.06.002>
- Rambaree, K. (2012). Three Methods Of Qualitative Data Analysis Using ATLAS . ti : " A Posse Ad Esse ." In *ATLAS.ti User Conference 2013* (pp. 1–15). <http://doi.org/10.14279>
- Rozza, J. P., Richter, B. D., Larson, W. M., Redder, T., Vigerstol, K., & Bowen, P. (2013). Corporate Water Stewardship: Achieving a Sustainable Balance. *Journal of Management and Sustainability*, *3*(4), 41–52. <http://doi.org/10.5539/jms.v3n4p41>
- Ruiters, C. (2013). Funding models for financing water infrastructure in South Africa: Framework and critical analysis of alternatives. *Water SA*, *39*, 313–326. Retrieved from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502013000200016&nrm=iso
- Rumelt, R. (2011). *Good Strategy Bad Strategy*. New York, USA: Crown Publishing Group.
- Saleth, R. (2000). Institutional changes in global water sector: trends, patterns, and implications. *Water Policy*, *2*(3), 175–199. [http://doi.org/10.1016/S1366-7017\(00\)00007-6](http://doi.org/10.1016/S1366-7017(00)00007-6)
- Sanberg, P. (2010). *Vision 2050 - the new agenda for business* (No. ISBN: 978-3-940388-56-8). Conches-Geneva: WBCSD. Retrieved from http://www.wbcd.org/WEB/PROJECTS/BZROLE/VISION2050-FULLREPORT_FINAL.PDF
- Saunders, M. ., Lewis, P. ., & Thornhill, A. (2012). *Research Methods for Business Students* (6th ed.). London: Pearson Education Limited. Retrieved from <http://www.myilibrary.com.esc-web.lib.cbs.dk/?ID=819487>
- Saunders, M., & Lewis, P. (2012). *Doing Research in Business and Management: An Essential Guide to Planning Your Project*. London: Prentice Hall.
- Schlosser, C. A., Strzepek, K., Gao, X., Fant, C., Blanc, É., Paltsev, S., ... Gueneau, A. (2014). The future of global water stress: An integrated assessment. *Earth's Future*, *2*(8), 341–361. <http://doi.org/10.1002/2014EF000238>
- Schmidt. (2015). Policy, planning, intelligence and foresight in government organizations. *Foresight*, *17*(5), 489–511. <http://doi.org/10.1108/FS-12-2014-0081>
- Schmidt, J. C., & Laycock, M. (2009). Theories of strategic planning. Retrieved May 5, 2016, from <http://www.healthknowledge.org.uk/public-health-textbook/organisation-management/5d-theory-process-strategy-development/strategic-planning>
- Schreyogg, G., Sydow, J., & Holtmann, P. (2011). How history matters in

- organisations: The case of path dependence. *Management & Organizational History*, 6(1), 81–100. <http://doi.org/10.1177/1744935910387030>
- Setia, P., Venkatesh, V., & Joglekar, S. (2013). Leveraging Digital Technologies: How Information Quality Leads to Localized Capabilities and Customer Service Performance. *MIS Quarterly*, 37(2), 565–590. Retrieved from http://www.vvenkatesh.com/wp-content/uploads/2015/11/Setia_Venkatesh_Joglekar_MISQ_2013.pdf
- Shakweer, A., & Youssef, R. M. (2007). Futures studies in Egypt: Water Foresight 2025. *Foresight*, 9(4), 22–32. <http://doi.org/10.1108/14636680710773803>
- Siegel, S. M. (2015). *Let there be water: Israel's Solution for a Water-Starved World*. New York, USA: Macmillan Publishers Ltd.
- Smit, B., & Pilifosova, O. (2003). Adaptation to Climate Change in the Context of Sustainable Development and Equity. *Sustainable Development*, 8(9), 9.
- Statistics South Africa. (2014). *Poverty Trends in South Africa*. Retrieved from www.statssa.gov.za/publications/Report-03-10-06/Report-03-10-06March2014.pdf
- Stewart, R. a., Willis, R., Giurco, D., Panuwatwanich, K., & Capati, G. (2010). Web-based knowledge management system: linking smart metering to the future of urban water planning. *Australian Planner*, 47(2), 66–74. <http://doi.org/10.1080/07293681003767769>
- Sydow, J., Schreyogg, G., & Koch, J. (2009). Organizational Path Dependence: Opening the Black Box. *Academy of Management Review*, 34(4), 689–709.
- UNESCO. (2009). *Water in a Changing World* (WWDR 3). Paris: United Nations Educational, Scientific and Cultural Organization. <http://doi.org/10.3390/w3020618>
- UNESCO. (2012a). *Facts and Figures - Managing Water under Uncertainty and Risk* (WWDR 4). Paris: United Nations Educational, Scientific and Cultural Organization.
- UNESCO. (2012b). *Managing water under uncertainty and risk*. (WWDR 4). Paris: United Nations Educational, Scientific and Cultural Organization.
- Utesheva, A., Simpson, J. R., & Cecez-Kecmanovic, D. (2015). Identity Metamorphoses in Digital Disruption: A Relational Theory of Identity. *European Journal of Information Systems*, (11), 1–20. <http://doi.org/10.1057/ejis.2015.19>
- Veolia Water. (2011). *Finding the Blue Path for A Sustainable Economy [White Paper]*. Retrieved from <http://www.veolianorthamerica.com/sites/g/files/dvc596/f/assets/documents/2014/10/19979IFPRI-White-Paper.pdf>
- Visser, W. (2015). *Sustainable frontiers: Unlocking change through business*,

- leadership and innovation*. Sheffield: Greenleaf publishing. Retrieved from https://books.google.co.za/books?hl=en&lr=&id=BL8yDAAAQBAJ&oi=fnd&pg=PP1&dq=sustainable+Frontiers+%252B+Wayne+Visser&ots=vUKzS_9EzO&sig=zqgg-XN0alfEHXgSvaMEGlas5ew
- Wang, Z., Song, H., Watkins, D. W., Ong, K. G., Xue, P., Yang, Q., & Shi, X. (2015). Cyber-physical systems for water sustainability: Challenges and opportunities. *IEEE Communications Magazine*, 53(5), 216–222. <http://doi.org/10.1109/MCOM.2015.7105668>
- Wayland, R. (2015). Strategic foresight in a changing world. *Foresight*, 17(5), 444–459. <http://doi.org/10.1108/03684921211275261>
- Wegelin, W. A., & Jacobs, H. E. (2012). The development of a municipal water conservation and demand management strategy and business plan as required by the Water Services Act , South Africa. *Water SA*, 39(3), 415–423. Retrieved from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502013000300011
- Wenzel, M., Wagner, D., Wagner, H.-T., & Koch, J. (2015). Digitization and Path Disruption: An Examination in the Funeral Industry. In *ECIS 2015 Completed Research Papers* (pp. 0–18). Germany. Retrieved from http://aisel.aisnet.org/ecis2015_cr
- Willis, R. M., Stewart, R. A., Panuwatwanich, K., Williams, P. R., & Hollingsworth, A. L. (2011). Quantifying the influence of environmental and water conservation attitudes on household end use water consumption. *Journal of Environmental Management*, 92(8), 1996–2009. <http://doi.org/10.1016/j.jenvman.2011.03.023>
- WWF. (2013). *Water stewardship: Perspectives on business risks and responses to water challenges*. Retrieved from http://awsassets.panda.org/downloads/ws_briefing_booklet_lr_spreads.pdf
- Zikmund, W. G. (2003). *Business Research Methods*. Ohio: South-Western, Cengage Learning.

Appendix 1: Research Questions and Prompts

Research Question set 1

- **RQ1: What are the current key components in the municipal water industry that currently plays a role in effective water stewardship?**
- Is the industry as a whole or in part good or bad at performing (Rating factor) the aforementioned factor? Why?
- What are some of the underlying country level driving forces (e.g. Macro factors) that could alter the performance of such factors? Why?

Research Question set 2

- **RQ2: What are the most important future factors that will play a role in improved future water stewardship practices, and that may transform water providers into world-class water stewards?**
- What role does water play in business, social life and the natural environment in the future? Why is it important?
- How do you think public private partnership (PPP) could encourage better water stewardship (in SA)? What are the things that will prohibit it or encourage it?
- What were some of the key technology changes in water industry over the last 5 years across the globe? Could it be used to help us change the way we manage water?

Research Question set 3

RQ3: How can ICT complement the sustainable water balance frameworks in order to enhance water stewardship and what are the opportunities and challenges associated with ICT?

- How could ICT empower us to share water? Why?
- How could ICT address equality and transparency in distribution of water? Why?
- How could ICT protect us and care for us with respect to water? Why?
- How could ICT help us to become more sustainable with respect to water? Why?
- How could ICT improve, inspire our lifestyle (culture) with respect to water to
- What factors will encourage or prohibit us from using ICT? Why?

Appendix 2: Job environment word count

This appendix illustrates that more likely than not, specific unique interests are at play within each job environment in the municipal water sector. Each of these working environments will be briefly discussed below. The prominent words from each respective environment were matched to the majority of discussions with the respondents within that particular working environment.

Explanation of abbreviations: WB = water boards, RI = research institutions, PVT = private company, NGO= Non-government organisation, GOV=Department of Water and sanitation (DWS).

WORD COUNT	WB	RI	PVT	NGO	GOV
PLANT	70				
MUNICIPALITY	66		15		34
PLAN	62	47			16
GOVERNMENT	50			41	10
MANAGE	48	37	14	30	
ICT	41	57		22	
SYSTEM		48	12	31	
RESEARCH	41	45			
TECHNOLOGY		39	34		
INFORMATION			32		8
SERVICE			16		12
DATA			12	35	
COUNTRY				29	
DEPARTMENT					20
MAINTENANCE	38				
METERING		44			

WORD COUNT	WB	RI	PVT	NGO	GOV
RESOURCES		24			
ENVIRONMENT			13		
ACCESS				23	
INFRASTRUCUTRE				21	
MONEY					10
SUPPORT					9

WB: The utilities seemed to have a balanced operational view. Their focus areas were likely plant, maintenance, managing and planning, with a high dependability on their stakeholders like government and municipalities.

RI: The research institution seemed to focus a lot of their discussions on planning, systems, and technology. Then ICT, metering, resources and management were also mentioned and begs the question whether research in these areas might lead to a brighter future.

PVT: From the key words, their attention was primarily focused on the necessity of technology, information and data. The frequent mentioning of the words environment and municipality show that they were aware of their stakeholders.

NGO: The NGO was more inclined to talk about the country, government, infrastructure, management and current systems. It also seemed as if they were interested in the accessibility (or availability) of data.

GOV: The word summary of government reveals that a lot of emphases were placed on intra government system with words like government, municipalities and department. They also talked about the national water plan with reference to money and support.

Appendix 3: ATLAS.Ti funtions

In order to clarify the ATLAS.ti terms that are used during the explanations a summary of definitions are provided here.

TOOL	DEFINITION
Word Cruncher	This tool allows users to count the frequency of words in a selected textual PD's. A stop list is usually defined and applied to clean up the word count from unwanted special symbols or common words.
Code Co-occurrence Table	If a single quotation is coded by two codes this would count as a single co-occurrence. The total number of times two codes overlap or co-occur is counted and displayed within table. The higher the co-occurrence the stronger the relationship between two codes is (which is similar to a type of correlation coefficient).
Query Tool	Finds quotations based on combination of codes and Boolean commands. Generally, the tool is mostly used to create super codes from multiple codes e.g. *CF:Planning&Strategy&#Rating:POS . This super code uses the AND operator (highlighted in bold). This query would only report quotations where both the individual codes were used together. It might seem similar to the co-occurrence table, but the query tool also allows you to conduct a 'share of voice count' on the super code of interest (refer to Codes-primary table Words).
Codes-Primary document Table - Quotation	This table is a cross-tabulation of codes by primary documents and shows how often (frequent) quotations has been applied to a document or attribute code. The output of this function is of similar use as in the case of the co-occurrence table.
Codes-Primary document Table - Words	This table shows the word counts of quotations of each selected code. The output is used to determine the 'share of voice' for a particular theme or category. The 'share of voice' is measure as to the amount of time a respondent spent speaking about that concept or topic. It therefore highlights the importance they attached to that topic.

Appendix 4: Example of coding

An example of coding is shown in the extract from ATLAS.ti below. In this section of transcript, a respondent makes a follow-up statement with regards the diversity and variation across the different municipalities in South Africa.

INTERVIEWER Why would you say that there is a difference, from your experience on the issue? What is the main reason for the big variance?

RESPONDENT It has [indistinct] factors outside the water sector, it has to do with history of the different municipalities, how they are capacitated with skills level that is then present in the leadership at the municipality. It has to do also very broadly with incentive schemes that are installed for municipal employees. And then we have places where the challenges are just paramount and they are just basically turning around in circles.

#Interviewer

#Gender:Female

#GroupType: Non-operation

#Jobenvironment:NGO

#RES07:NK

CF:HumanResources~

CF:Context(history)

CF:Governance&Management~

CF:FinancialBudgeting&Funding~

#Rating:NEG (Bad/Difficult/Excluded/Expensive)~

Based on the preceding statement, the interviewer formulated a on the spot question that would prompt the respondent to explain a bit more about her earlier statement. Given her reply, several listed codes were selected to code different parts of the follow-up statement. These codes included;

- 'CF:Context(history)'
- 'GOV:Local Level',
- 'CF:FinancialBudgeting&Funding',
- 'CF:Governance&Management',
- 'CF:HumanResources'

As is indicated, each code is presented by a colour and bar that represents the part of the sentence that has been selected to correspond to a specific code.

Attributes are indicated by '#' at the start of each code. A number of attributes like gender, credentials and job environment were auto-coded by ATLAS.ti to help trace and identify the origin of each quotation. The following codes, as seen in the extract were autocoded:

- `#Gender:Female`,
- `#RES07:NK`,
- `#Grouptype:Non-operation`,
- `#Jobenvironment:NGO`.

Lastly, most responses were rated with respect to an overall negative or positive impression or quality e.g. `#Rating:NEG (Bad/Difficult/Excluded/Expensive)`. The reason for implementing a rating attribute is to assist with the analysis of respondent opinion. Although lumping of codes as described here goes against the general recommendation as stipulated by ATLAS.ti help files, it should be noted that codes were only grouped together after the initial inductive convention had been completed.

The transcripts were all fully coded in correspondence to above mentioned scheme and the NCT procedure, which can be broken down into three steps;

STEP 1: Notice data. Thus data has to be found within each transcript.

STEP 2: Collect data. `Collect` the data via inductively coding it.

STEP 3: Think about the data. Applying reflexivity (May & Perry, 2011) on the noticed and collected data. Then group data with similar topics.

The steps were repeated until sufficient evidence on the research theme of water stewardship was found with respect the factors in current practise, the perceptions and importance of future factors as well as the opportunities and challenges for the uptake of ICT within the sector.

A detailed list of all codes that were used in this study is provided below:

#contradict/compete	#Rating:NEG
#Gender:Female	(Bad/Difficult/Excluded/Expensive)
#Gender:Male	#Rating:Neutral/Inbetween
#Grouptype: Non-operation	#Rating:POS (Good/Easy/Included)
#Grouptype: Operation	#RES02:NS
#Interviewer	#RES03:MG
#Jobenvironment:NationalDepartment	#RES04:KN
#Jobenvironment:NGO	#RES05:ND
#Jobenvironment:PrivateCompany	#RES06:VB
#Jobenvironment:ResearchInstitute	#RES07:NK
#Jobenvironment:WaterBoards	#RES08:TA
#Rating:N/A	#RES09:DN



#RES10:AA	FF: Integrated Collaborate System (Innovate)
#RES11:TP	FF: Management & Legislation
#RES12:PR	FF: Offgrid
#Theme0-General	FF: Planning & Goal
#Theme1-Current Factors	FF: Public Participation Awareness
#Theme2-Future Factors	FF: Recycle
#Theme3-ICT factors	FF: Resource allocation key (natural & human)
Best practice: Countries	FF: Revenue Collection & Pricing & Value Water
Best practice: Program	FF: Security / Prevent illegal Use
Best practice: Technology	FF: Technology / Products
CC: Behaviour change	FF: Trust / Accountability
CC: Complex System	FF: Willingness build / Implementation
CF: CURRENT FACTOR	GOV: LOCAL LEVEL
CF: Access & Service delivery & Equity	GOV: NATIONAL LEVEL
CF: Admin & Bureaucracy & firefighting	GOV: PROVINCIAL LEVEL
CF: Business Challenges & Participation	ICT access to information
CF: Consolidate / Merge / Scaling Economies	ICT: INFORMATION AND COMMUNICATION
CF: Context (history)	ICT: Challenges
CF: Data collection & interpretation	ICT: Data collection
CF: Dichotomy & Silo	ICT: Opportunities
CF: Drought & Water Scarce	ICT: Safe
CF: Equity	ICT: Satisfying
CF: Financial Budgeting & Funding	ICT: Security
CF: Governance & Management	ICT: Share
CF: Growth Demand Increase	ICT: Smart
CF: Habits & Water losses & Non Rev	ICT: Sustainable
CF: Human Resources	LG: GROUPE LEVEL
CF: Infrastructure	LG: Design components
CF: Legislation & Policies & Conserve	LI: INDV LEVEL
CF: Maintenance	LI: Design components
CF: Operation Monitoring Reporting	LO: ORG LEVEL
CF: Organisational Structure	LO: Design Component
CF: Perception & Human Behaviour	MF: Macro Factor / PESTLE
CF: Planning & Strategy	MF: Economic
CF: Pricing & Billing & Collection	MF: Legal / regulation
CF: Programme & Tools	MF: Political
CF: Public Participation Awareness	MF: Social / Environment Urban / Rural
CF: R&D	MF: Technology
CF: Regulation & Enforcement	ML: Environment
CF: Sharing Collaboration Network	Quotable Quote
CF: Stakeholders & Partnerships	Think Oupa Coenie Quote Measuring
CF: Technology	Waterboards
CF: Training & Education	Water Importance
COUNTRY LEVEL	Water losses
Crisis	Water stewardship
CSIR	Water stewardship Policy
DWS	Water Systems
Elections	WSA
Examples	
FF: FUTURE FACTOR	
FF: Automated	
FF: Climate Change & Global Warming	
FF: CSR	
FF: Data collection	
FF: Fit for Purpose & Reliable	
FF: Governance & Management (better decisions)	
FF: Green Economy	
FF: Health Pollution Free	

Appendix 5: Top ten word counts

Highlighted cells indicate the top ten words utilised by each respondent. Their working sector are provided for ease of reference.

WORDS	WB	NGO	RI	WB	PVT	NGO	PVT	WB	RI	WB	GOV	TOTAL
	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12	
WATER	162	130	127	54	46	116	45	94	166	20	80	1040
PEOPLE	33	23	20	16	18	20	10	24	44	4	35	229
MUNICIPALITY	20	0	16	7	0	7	15	39	1	0	34	139
PLAN	14	14	20	14	5	1	4	23	27	11	16	135
ICT	19	17	30	2	1	5	2	16	27	4	2	125
MANAGE	20	19	16	12	5	11	9	3	21	13	2	121
GOVERNMENT	19	16	12	0	7	25	0	31	5	0	10	118
SYSTEM	8	23	18	0	7	8	5	16	30	1	5	115
TECHNOLOGY	17	16	2	14	30	3	4	9	37	1	2	105
PLANT	26	0	6	22	3	0	0	20	0	2	6	85
INFRASTRUCTURE	9	19	4	12	0	2	4	8	18	4	5	85
DATA	0	31	4	0	2	4	10	10	11	2	0	74
INFORMATION	4	9	4	9	29	10	3	14	3	7	8	71
MONEY	7	5	6	3	0	3	3	13	17	0	10	67
DEPARTMENT	3	0	7	3	0	8	4	12	5	0	20	62
COUNTRY	16	13	6	4	0	16	0	4	15	4	1	60
RESEARCH	1	8	24	1	11	1	0	1	21	1	1	59
SERVICE	5	6	3	2	0	3	16	5	4	1	12	57
ACCESS	1	17	4	1	0	6	3	0	18	0	5	55
MAINTENANCE	9	3	1	22	0	1	3	7	1	0	3	50
QUALITY	8	2	7	8	0	9	4	5	5	0	2	50
RESOURCES	1	8	11	0	0	5	1	2	13	5	3	49
METER	7	3	0	0	0	0	0	0	38	0	1	49

WORDS	WB	NGO	RI	WB	PVT	NGO	PVT	WB	RI	WB	GOV	TOTAL
	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	P 12	
WASTE	6	2	2	0	1	6	0	13	8	7	2	47
IMPORTANT	3	22	1	5	0	7	4	0	3	0	2	47
NATIONAL	2	9	14	0	0	3	0	8	3	0	7	46
LOCAL	0	14	6	0	0	0	0	22	0	1	3	46
AREAS	6	6	2	4	0	5	3	4	10	3	2	45
SMART	2	12	6	0	0	2	0	0	22	0	1	45
NETWORK	0	8	0	6	0	0	0	0	24	0	1	39
DEVELOPMENT	3	7	1	2	8	6	0	3	11	1	3	37
PUBLIC	1	2	4	0	0	4	4	3	7	6	4	35
INDUSTRY	5	3	0	3	0	5	1	2	9	5	1	34
SERVICES	0	11	6	2	0	1	6	1	3	1	2	33
PERSPECTIVE	0	11	1	0	0	5	7	0	4	0	3	31
BUSINESS	0	7	2	1	0	11	1	0	4	0	3	29
OPERATIONS	6	1	1	11	0	0	3	6	0	0	1	29
RURAL	1	5	3	1	0	1	7	5	4	1	0	28
SKILLS	3	2	2	0	0	1	2	6	0	6	5	27
SUPPORT	0	1	1	0	0	10	0	2	1	1	9	25
CITIES	0	19	1	0	0	0	0	1	1	1	0	23
STEWARDSHIP	0	0	3	0	0	17	1	1	0	0	0	22
SOCIETY	0	3	1	0	0	15	2	0	0	0	0	21
ENVIRONMENT	1	1	1	1	11	1	2	3	6	1	0	17
SOCIAL	0	3	2	0	0	3	6	0	2	1	0	17
EDUCATION	1	1	0	1	8	0	0	0	3	1	2	10

Appendix 6: Current Factor Coding by Individual

Resp.	Quotes and codes illustrating current factors
1	<p>"We end up funding other people's lifestyle and everything instead of directing that money into infrastructure improvement or even installing new plants and new pipelines. But ideally yes, because everything that is private it runs perfectly, or it runs very well compared to what this government – but the issue which I know why the government doesn't want to take the water and privatise it, is that water is a national asset"</p>
	<ul style="list-style-type: none"> • The issue of privatising coded as CF:Business&Participation and #Rating:NEG • The benefit of privatising coded as CF:Business&Participation and #Rating:POS • Importance of water being a national asset coded as CF:Business&Participation and CF:WaterImportance
2	<p>"There specifically the infrastructure sorry, my coffee is still taking effect, ya and it's worse dissecting there because this is where this dichotomy plays out at a local level between who manages the resource and who manages the capital for that so there's utilities that play quite a strong role but they are really focused at a local level and that's how the city generates revenue as well so they focus very much on the services and billing for them. The resources are different story and there they have been a world for underinvestment and understanding the role of resources itself. Both whether it's in terms of rivers and wetlands or dams or infrastructure and the catchment as a whole, which is land and pollution levels are incredibly high and the classic is case is like in my back yard you know that we urban residents on which are a part of you know we turn the tap open and there is water there, we do not feel drought in the same way that other people do."</p>
	<ul style="list-style-type: none"> • Dichotomy and manages is coded as CF:Dichotomy&Silo's and CF:Governance&Management and #Rating:NEG • Underinvestment and understanding in resources CF:Legislation&Policies&Conserve and #Rating:NEG • The human behaviour and perception with regards to running water is a given when turning the tap was coded as CF:Perception&HumanBehavior • 'Do not feel 'drought' was coded CF:Drought&WaterScarce
7	<p>"I have done a lot of work with mostly the rural water service authorities, that's why I was asking whether the distinction between your urban ones, because they seem a lot further in terms of IT, even how they use GIS or the operations and maintenances, whereas the smaller more rural municipalities are not there yet. You would be lucky if they have a full list of all their water treatment plants. So that's how different they are."</p>

	<ul style="list-style-type: none"> • TheThe difference between rural and urban is looked at from a governance and management ability as well as variance in macro social factors. It is coded as MF:Social and CF:Governance&Management • There is also an element of contradiction in the use of technology. This was coded as CF:Technology and #Contridict&Compete
3	<p>"Yes, they do not get it, because I still get water in my house, I can still water my lawn, there is nothing that happens to me. I think that is there [indistinct]. I do not think that we are doing a good job educating the public and also raising that awareness that we need to use water wisely, we must recycle, save water.</p> <p>"It is just exposed, that the drought just exposed us that our planning is not good enough."</p>
	<ul style="list-style-type: none"> • All statement have a negative connotation therefore a #Rating:NEG • Lack in education coded as CF:Education • Lack of raising awareness as CF:PublicParticipation&Awareness • The poor planning with respect to drought CF:Planning&Strategy
4	<p>"Recently I told you that I went to the WISA and my main reason of going there was to look into maintenance and operations and how far, at what level are we. One thing that came through and I think it came through to everybody who was sitting in those conference rooms that were representing operations and maintenance, the one thing that was important was that there is not much that is being done to develop or train people in the water industry, there's not much that is being done at all in fact there's very little budget that goes towards those guys, very little. Rand water might have a specific budget that talks to operations and maintenance but somebody else in Bloem water is not talking the same language and somebody in Brits plant is not talking the same language or somebody else in the municipality doesn't even worry about the budget that must go to the infrastructure."</p>
	<ul style="list-style-type: none"> • All statement have a negative connotation therefore a #Rating:NEG • Lack in education coded as CF:Education • That each municipalities word differently talking their own language hence a silo approach coded as CF:Dichotomy&Silo • That budgeting is different for the respective municipalities and coded as CF:FincialBudgeting&Funding • Neglecting infrastructure in budgeting CF:Infrastructure
8	<p>Well if you look at the different clients I think the Department of Water and Sanitation often has a much longer planning horizon which I think should be the right way anyway. And then your municipalities are very much confined to their political cycles, at least this has been the hype for the past year or two, probably because of this batch of elections. So you get the municipalities looking at much shorter periods of time. That is probably one to three years.</p>



	<ul style="list-style-type: none">• Planning is done on respective levels of government. CF:Planning&Strategy.
11	<p>"I am going to say, we are irresponsible citizens. We do not care."</p> <p>"For us, ag, I am working, I am 'PR', what is the problem? I am paying them, so they must give me the water."</p>
	<ul style="list-style-type: none">• Example of human behaviour as CF:Perception&HumanBehavior

Appendix 7: List of Current Factors and share of voice

Number	CURRENT FACTOR	GOV	NGO	PVT-CON	RI	WB	TOTAL
1	CF:Planning&Strategy	6%	5%	3%	8%	11%	8%
2	CF:Governance&Management	6%	11%	10%	8%	3%	7%
3	CF:PublicParticipation&Awareness	2%	7%	4%	8%	9%	7%
4	CF:FinancialBudgeting&Funding	16%	3%	1%	6%	6%	6%
5	CF:Perception&HumanBehaviour	2%	5%	4%	5%	7%	5%
6	CF:Stakeholders&Partnerships	1%	12%	4%	6%	1%	5%
7	CF:Business&Participation	0%	8%	2%	4%	8%	5%
8	CF:Legislation&Policies&Conserve (CMA's)	4%	6%	8%	5%	4%	5%
9	CF:HumanResources	11%	2%	14%	2%	7%	5%
10	CF:OperationMonitoringReporting	0%	4%	7%	5%	5%	5%
11	CF:Infrastructure	7%	7%	3%	2%	5%	4%
12	CF:Habits&Waterlosses&NonRev	2%	1%	0%	9%	0%	4%
13	CF:SharingColloborationNetwork	1%	2%	7%	6%	1%	4%
14	CF:Technology	0%	3%	3%	5%	2%	3%
15	CF:Context(history)	3%	4%	1%	0%	6%	3%

Number	CURRENT FACTOR	GOV	NGO	PVT-CON	RI	WB	TOTAL
16	CF:Training&Education	5%	4%	2%	2%	3%	3%
17	CF:Maintenance	3%	1%	4%	2%	5%	3%
18	CF:Regulation&Enforcement&Polute	7%	2%	4%	2%	2%	2%
19	CF:Programme&Tools	0%	5%	3%	1%	1%	2%
20	CF:Access&Servicedelivery&Equity	4%	1%	5%	1%	2%	2%
21	CF:Datacollection&interpretation	0%	0%	0%	1%	3%	1%
22	CF:R&D	0%	0%	0%	3%	0%	1%
23	CF:Drought&WaterScarce	2%	1%	2%	1%	1%	1%
24	CF:Pricing&Billing&Collection	2%	1%	0%	2%	0%	1%
25	CF:OrganisationalStructure	2%	1%	2%	1%	2%	1%
26	CF:GrowthDemandIncrease	3%	1%	2%	0%	2%	1%
27	CF:Admin&Bureaucracy&firefighting	7%	1%	0%	0%	1%	1%
28	CF:Equity	0%	1%	1%	1%	0%	1%
29	CF:Dichotomy/Separation/Silo	0%	1%	3%	0%	0%	0%
30	CF:Consolidate/Merge/ScalingEconomies	0%	0%	0%	0%	1%	0%

Appendix 8: Current Factor Results for Respective Working Environments

Appendix 8.1: Government

Resp.	Quotes	Key words
11	"That is where I am saying, have you warned that [indistinct], no, because all they would want is that we continue paying for that person . And you say, but this person must become part of the system, but in some cases you find, even if you leave this student learner there is no mentor ...The person will not grow."	Shortage of financial and mentoring prohibits vocational training.
11	"We have found that in some cases the budget for COE is limited . They do not have enough budget to hire the right skilled people."	Budget deficit prohibit hiring the necessary skills
11	"When we do the Blue drop and Green drop assessment we find that those things are not there. You ask why and they give a financial constraint – we do not have ..."	Financial constrain given as reason for non-compliance
11	"And then also you find that there are people who have been working there for quite a very long time who are not – they are skilled, they know their job but from a qualification point of view they do not have, so you must start – we have encouraged RP, recognition of prior learning and you move them. But remember, as from a labour perspective as you train a person and what, what it means their salary must – so they have come out with all those arguments. Ey, you are making these people more wiser, you know, it is ..."	Recognition of prior learning is used to fill vacancies
11	"I am going to answer you indirectly in the sense that the way, from my experience, budget constraint reasons are different from one municipality to another."	Budget constrain
11	"Now when you say it is this person in the water service it means that they must be accountable and responsible . They have got the authority to take decisions on water provision. They will ensure that there is capacity. You heard I said they will ensure, they will ensure that there is financial resources, planning, operation and maintenance and the like."	WSA has to be accountable and responsible for all aspects of decision making with respect to water provision.
11	"In some municipalities you would have a water section as a stand-alone, you see. Now, if they are part of a bigger engineering section they would compete their budget with all other units in that section . But where they are a stand-alone at least the head of that unit is able to – what I	Competing budget

Resp.	Quotes	Key words
	found mostly they will say we are not given the priority."	

Appendix 8.2: Non-government organisations

Resp.	Quotes	Key words
2	You can't, you can't there's no gravity so how do you and there's the constitutional mandate to be able to give access to this services so what do you do in that space, very innovative ... and then it's fit for purpose technologies and they went and had a community-based approach, the bulk of their money was spent not on developing technology and infrastructure but on engaging with the community and that's the other shift is that you go to people ...for most part it's been accepted by the community because they put in the alternative approaches."	Basic technologies (fit for purpose) is required for communities living in remote areas
6	"So we actually thought about it quite thoroughly, and for us water stewardship highlights the responsibility of each and every actor and stresses the fact that also we are not looking at the system from the outside and then say, okay, actor a, b, c, d we must co-operate and we must be integrated and then it will be fine... So and we are saying, okay, we need to look at the inherent motivation of each and every actor to then come to the party basically to become part of that stakeholder interaction around water security."	Water stewardship include responsibility and inherent motivation as part of stakeholders
6	"So our expectation is that civil society plays quite a fundamental role but it is difficult to get them on board because they are often not organised and they don't have a voice. But it is actually quite a requirement from the department side, from the minister's side even, that there needs to be more civil society involvement."	Civil society is often unorganised
2	"Sure, okay daily frustrations in relation to water I think the fact this, the silo approach we have to managing water that and that relates to both the silo approach both in terms of the engineering versus the land versus the environmental approach to water catchment agency and then the other silo approach between water affairs involving the government... "	Silo approach between sustainable engineering and politics
2	"...this is where this dichotomy plays out at a local level	Dichotomies in

Resp.	Quotes	Key words
	<p>between who manages the resource and who manages the capital for that so there's utilities that play quite a strong role but they are really focused at a local level and that's how the city generates revenue as well so they focus very much on the services and billing for them. The resource is different story and there they have been a world for underinvestment and understanding the role of resources itself."</p>	<p>management</p>
6	<p>"I mean on the one hand we are seeing a water crisis in South Africa, which has also been confirmed by experts, but on the other hand water dependant industry sectors don't seem to see any reason to disclose above and beyond what they used to do, or they don't show much interest in disclosing their responsible practises through that program, which would in theory give them security and access to financial markets or the goodwill or the interest of investors."</p>	<p>Dichotomy: Generate revenue at local level vs. lack of investment in resources</p>
2	<p>"I would say the biggest hindrances we have in this country is that we have two water acts that we think that when the water will attack one law, e.g. when it's in the river it's a different resource than when it rains on the road."</p>	<p>Transparency of business</p>
6	<p>"I don't think it is the right way to go at all, but still there needs to be – and actually I have to say that the department is moving in that direction and needs to be at a constant engagement with the private sector partner so that there is a stronger understanding for we are in this boat together."</p>	<p>Two water acts are contradictory</p>
2	<p>"... in my back yard you know that we urban residents ... we turn the tap open and there is water there, we don't feel drought in the same way that other people do."</p>	<p>Collaboration with private sector</p>
6	<p>"And then they are getting – okay, they are very aware of how much they spend for the water and the security around water, and they are also aware of the responsibility they have for assisting the government in order to play its role, because this is the situation that we are in in some cases, because the water management in the government side, especially on the technical level, is lacking. So in terms of the maintenance. So they see that and they are also – their argument goes like, we are doing this, we are assisting them there, we are actually monitoring for example the Vaal system. We are already contributing so much and that is all from their perspective. Now it is quite likely even that water</p>	<p>Business collaboration is essential to manage security and risk. Since technocrats are sparse in government, business often assists the regulator with expertise.</p>



Resp.	Quotes	Key words
	prices will go up. And then there is this moment where they decide, or where they indicate that at least they are going to threaten with – say, okay, if that happens it is no longer attractive for us to do business in South Africa and then they don't want to withdraw."	However water price hikes could make business unattractive.
2	"It still a consumptive resource consumption based plan and that's the struggle we have in this country, we still see growth as being linked to consumption of resources that means water and minerals or whatever it is. So there are still challenges within our national policy when it comes to that which has implications for water and that hasn't quite sunk in yet. So water I mean it's absolutely central and it's crosscutting to pretty much everything the NDP has and does but the NDP itself is not enough because of this consumptive driven approach that we have. "	National prices and development and con
2	"There is no group data particularly for water at most government levels, boundaries don't match so the local government boundaries doesn't match the catchment boundaries, it doesn't match the system, it doesn't match with National (inaudible 54:29) so from a city perspective they can get data from the utility or from Rand water but who leads your holistic water management (inaudible 54:37) and we don't do it and we don't share data . So the other is we doing very poorly particularly on the resource side of it and the reaction is a lot of criticism on the misinterpretation of data so people shut down (inaudible 54:52) all the data."	Data source doesn't tie-up. Lack of data sharing Misinterpretation of data

Appendix 8.3: Private Sector

Resp.	Quotes	Key words
5	"So it is a continuous development with the one building on the other, but in the end of the day there is two factors that count, the human that checks on the machine, and that maintains it, and the machine that needs to be trusted that it will be able to complete its task, again and again, without any risk, or very little risk."	Human and machine Human to maintain Machine to execute task
5	"The monument that I leave behind after I go is not this	Humans are



Resp.	Quotes	Key words
	system that is standing here, through which the planning was done. The monument that I leave behind is the people , the human capital."	important legacy
5	"Luckily, since there is a greater amount of decision makers, we decided that we should set up a list with touch points. Department of water and sanitation has specific requirements, and so does mining and energy, and environment affairs. We look at which of these requirements are similar in nature , and those we satisfy as soon as possible."	Common goals
7	"...if the municipality does not have monitoring points, if they haven't been sampling sufficiently, if then when speaking to ...you are not giving them the warnings that they are supposed to until they can take them to task, they can't do it. So we all know who is polluting but you need to have a good story...Could be one of the reasons. I think when you say house in order, with water quality you always have the challenge of the skill that you require to check on compliance and for you to be able to actually bring an industry, for instance, to book you would have to have your story in order to do that. And I think that is one of the challenges, how do they put together a case that would be able to stand if it was to be tested by a court system, because that is what regulating condition is all about...Good legal teams and are happy to lose some money just to get off"	Skill and human capital availability in compliance monitoring.
7	"...the thing is you have a society on the one hand which is very sophisticated and on the other hand which is very simple and you are trying to manage these two very different things and that makes it very, very difficult..."	Classes in society, management thereof.
7	"So we need to organise ourselves a lot more and right now I don't see anyone working on that space. "	Lack of organisation.
7	"I think one of the challenges is really your turnover , as long as you have a very high turnover you cannot have that transfer happening."	Referring to turnover of human capital, and the lack in knowledge retention.
5	"And that no provision have been made for the drastic increase in populations, especially in the cities . There is increased pressure on all the systems. You know that people moved, the closer they are to where they work, the better it is. Less transport, easier to get to work, and more time at	Urbanisation and increased pressure on already fragile water industry.



Resp.	Quotes	Key words
	home. Houses becomes available. So everything, the ablution facilities, clean water, everything is placed under pressure . Everything, everything that entails water is placed under pressure."	
7	"Now, if the water service authority does not take on its role as a regulator of service with all the policing and the whistle blowing that is supposed to happen with polluting industries and with themselves also not compliant , you actually have a problem. So they tend to be the biggest polluter in their own environment ."	Regulation of pollution, non-compliance of management.
7	"And very often in my space the municipalities expect a consultant to then come in and do something for them, but the moment you leave then that whole thing falls over ."	Lack in management and implementation.

Appendix 8.4: Research institutions

Resp.	Quotes	Key words
3	"As well as the strategies, you know what a strategy, once you develop a strategy immediately you have to do an implementation plan. And most of the time that strategy is there and that implementation are either not there or it is there but it is not being implemented ."	Implementation plan are lacking.
3	"And also, sometimes there is a thin line between your political and technical, because all the decisions they are done at the political level ."	Politics play a role in decision making.
3	"The water treatment plants are not functioning optimally . And I think currently only five percent, according to the recent records... So we have also a problem with compliance monitoring and enforcement ."	Poor performance and compliance.
3	"...that the drought just exposed us that our planning is not good enough ."	Insufficient planning.
3	"Like every year I need to have a strategic research plan for my research group, but then that – my portfolio plan it contributes into the corporate plan, which is over five years. And then we also report to the department , we also	Planning

Resp.	Quotes	Key words
	contribute to even the non-clients like your national delivery plan, the national water research development innovation, road maps, those are longer term plans. There is even like the SDG's. There is one as the long plans, but if you have seen them recently you will see that they are centred around water and sanitation."	
9	"Should we use smart meter or just using dumb meter because if I use normal meter I can instead of deploying thousand meter I can deploy 3 000 with the same cost, and can serve me for now, isn't it? Because now every connection is done, but after few years from that the normal meter cannot help me further. "	Decision making that will impact the future.
9	"...every three months, the third month they send somebody to take, then the second month estimation and so on. And some tell us there is no clear any information about it, but still we know that it is just about estimations not really actual reading. With the smart meter issue, if it is automatic, that can make it easier, but still, as I said, because of the limited funding available as if it has come to the director of specific department for them at the end of the day is how to install more meters with the given amount of money. So the choices for him at the end of the day they always go for to have the normal meter instead of having smart meter, for example."	Budget sharing in municipalities limit funding to water departments.
3	"...problems with the skills, not that we don't have any use in the country, local government fails to attract the right capacity , and the problems they are a combination of political to financialproblem is that the salaries "	Human Resources, especially skill is important.
3	"There has to be a different model for the municipalities that are not resourced or the poorer communities , which I don't know whether it is something that could be managed at a district level , because at local it does not work."	Management models are different for poor communities.
9	"There is some kind of initiative there but it is not to the level that it is supposed to be in a country that's in the current situation that we have in this country, the scarcity of the water or the crisis that we are facing in the water domain. We should have more in fact in that because saving water at the end of the day it can assist the limited resources that we have. So it is not about revenue , even we get revenue out of it, but so we use a lot of money that can be saved."	Both sustainability and saving money is important.



Resp.	Quotes	Key words
3	"Yes, they don't get it , because I still get water in my house, I can still water my lawn, there is nothing that happens to me."	Perception of drought.
3	"...feasibility they had rejection – there was a group that really was against the water reclamation plant because they thought that the water will not be clean and also they thought that there are better options."	Perception around reuse of water.
9	"Even now, you see the drought is just a few months back finished and everything now will go back to normal life . It is not like, if you remember we were telling that time the media everywhere and just speak about water, even forget about electricity at all. But now since we done from it we go back to normal life and I am not sure if ..."	Perception of drought.
9	"...we have something that we call it, they have to approach to detect the leaks... active approach.... and the first time I thought about active I thought it is an ICT system . And for them it is for example when the people who bought it, while the active, the generator team from the city and they send it to the critical areas, like Mamelodi, Soshanguve where the infrastructure they know is very bad. So this team it just moves in the street and see if there is a physical leakage. This is what they call active kind of approach. So for me when I heard the first time this term where they said, active, I thought it is something bigger than system that detected that . Because they said this is very cheap kind of approach. We cannot apply it across the city, this is why they identify specific areas."	Perception of active approach to solving leaks.
9	"So we highlight five clusters based on the consultation with the city, as well we have workshop where we invite several stakeholders and then we try to select this area based on urgent need, which is merely the water loss reduction, ICT for water management and then we have waste water and drinkable water to cluster, and we have sludge management cluster and finally the smart infrastructure, big cluster."	Collaboration

Appendix 8.5: Water boards

Res	Quotes	Key words
1	"So we do plan for five years and we also do plan our	Planning cycles.

Res	Quotes	Key words
	<p>infrastructure based on IDP's."</p> <p>"Sometimes we don't even get those IDP's. We don't even – we have to estimate, using our own experience to say, okay, the water has been increasing by so much, let's adjust to that. But ideally, in an ideal environment, when the township or a suburb is being expanded, we should be the first one, like Eskom, to be notified that in five years' time we will be having so many units, houses that will be built."</p>	<p>Not being informed by municipalities of new housing projects.</p>
1	<p>"There is something we call a corporate plan, which comes from our stakeholder engagement.. And we plan for five year horizon, but we review it every year. So that means it keeps on changing. We submit it, we are forced by law because our stakeholder or the shareholder is the government."</p>	<p>Planning cycles</p>
4	<p>"We make a request based on what we experience whether this thing is it achieving the required output or not if not then we make that request, they come out and they do their own assessment and then they will then recommend to say okay put it in the budget or they write what they call a PPIR pre-project investigation report, they write that in there they tell to say what is it that they recommend should be done. The project should be started or not and then they rate it according to the priorities and then it goes to the next financial year it means now that we have a project that we are going to be doing next financial year."</p>	<p>Project/Funding request. Planning cycle.</p>
10	<p>"We plan 20 years ahead at the systems[?] level in terms of water resources and population growth."</p>	<p>Planning cycles.</p>
10	<p>"Yes, it is available to the public. Then on a detailed planning it is a five year period which is really the projects that are in the construction phase. With most water and waste water works it is typically a three to five year period from detail design to commissioning."</p>	<p>Planning cycles.</p>
10	<p>"I think holistically we have got very good legislation, very good planning, but very poor at implementing the legislation or the plans."</p>	<p>Good planning</p>
10	<p>"There are some areas where the planning is poor and there are some where it is very good."</p>	<p>Areas of poor planning</p>
1	<p>"And any complaint that they have, it can be the quality. Either a shortage of water or anything that they are complaining about. Maybe even reporting some activity of</p>	<p>Public participation in identifying problems</p>



Res	Quotes	Key words
	some of our employees , maybe that does not supposed to be involved in, they will call us. It is like, yes – and at night, for now, the calls are recorded and then during the day when the – because it is only working from 08:00 to 16:30.”	
8	“So there should be more engagement at the community level in terms of the ownership . If you look at other countries where they have what they call CBO, community based organisations that would basically run these water stewardship and water related issues to make decisions, especially for rural areas, to make decisions about what should we do to preserve this water.”	Public participation
4	“I don’t think there is an awareness out there with the ordinary person whose on the street if he does understand where this water is coming from , how does it get to this stage that it comes trickling out of my tap and I must take care of it.”.	Public perception with regards to water as a resource
8	“Yes, I know from government’s point of view it might be issues around once you are starting to use technology what about jobs? ”	False public perception
8	“So we are still stuck a bit in our traditional ways , obviously for a number of reasons, maybe from the local municipalities point of view of those things regarding maintenance and one not having had appreciate that the technology to that point.”	Perception around technology
1	“But with the mines the impact is delayed for 48 hours, sometimes 72 hours, then the politics comes in. You are preferring the mines, the mines are not complaining that there is no water in their plants, but you guys are saying you don’t have water. And meanwhile they forget that what the mines are doing, they plan ahead, they respond to what we normally tell them and advise the customer to say, please make provision for at least 24 hours storage so that when we have a breakdown you don’t feel it immediately. But they don’t do that. ”	Insufficient communication, public perception
1	“But where you have this peak triple P thing whereby then again you have some other people having their own interest, particularly financially, then you find that there is money drained from government institutions. We end up funding other people’s lifestyle and everything instead of directing that money into infrastructure improvement or even installing new plants and new pipelines. But ideally yes,	Partnerships, allocation of funding, privatisation of water



Res	Quotes	Key words
	<p>because everything that is private it runs perfectly, or it runs very well compared to what this government – but the issue which I know why the government doesn't want to take the water and privatise it, is that water is a national asset."</p>	
1	<p>"I will employ you because you belong to a certain group or a certain party, not because you know what you are supposed to know."</p>	Human capital, Lack of skill acquisition
10	<p>"Again because they don't want to live out there, they tend to want to live in the bigger cities, so those skills are difficult to maintain in the remote rural areas where skills are required."</p>	Urbanisation, Human Capital
10	<p>"Whereas I think that those skills are available, and especially the technical skills are available. The only problem is attracting those skills to the industry is the hassle. In light of the skill engineers and sciences that are required are available in the country but they just – two reasons I would say that they are reluctant to join the sector is, one is the salaries are low compared to what they can earn in places like SASOL and if I am looking in particular at chemical engineers where industry would be paying them much higher and then the reluctance to join the industry. Similarly for mechanical and electrical engineers. So it is really hard to attract them to this sector, but they are available in the country."</p>	Human Capital and skill availability Retention of human capital and finances.
1	<p>"Again there is that buzz word or buzz talk that the country does not have skills. I always said, bull. We have so much skills in the country, people, graduates like yourself, and maybe even younger ones, are sitting at home without employment. The problem is how we employ."</p>	Human Capital and skill availability.
4	<p>"The area that I have experienced as a maintenance manager which is difficult to manage in terms of keeping the skill is the instrumentation section, the instrumentation section those guys are getting very huge money ya so if you are to keep them you really have to pay them."</p>	Human capital, skill availability and finances.
4	<p>"I'm not sure whether you know the war on leaks that was announced whereby the Minister is training artisans who will be employed, Rand water has already is currently training I think there is about 1000 that are busy under training because they took a bulk, there was about 3000 that</p>	Human capital and training.



Res	Quotes	Key words
	were identified for various areas so I think they've taken about 1000 with whom they are training. Those people will be deployed to the municipalities with the know-how in terms of how to maintain the municipality infrastructure. I think yes we have neglected the infrastructure in the municipality..."	
1	"I was actually talking more of financial leakages . Maybe the bad part of it is, though we do plan, but there are so many fingers in the pie , like I talk about leakages and everything, we are not doing very well when it comes to that."	Finances and budget allocation.
4	"Look, in terms of their planning, in my experience they are looking at them planning for just about 24 months , two years. So we would not have that forward planning of five years or so. Even though they would have what they call the intermediate[?] development plans and the master plans, the water master plan, some of them they don't even have such kind of water master plan, in terms of their planning of their infrastructure, they don't have. So it goes back to fire fighting, and it goes back to the fact that someone would say how do I now plan even though I don't know where am I going to get the capital injection , because I only rely on the national government to give me grants to implement my projects."	Planning and uncertainty with regards to finances.
8	"I think maybe over the past 15 years they got used to these planned funding and it has been confirmed to them annually. So they even, for whatever reason, stopped to think ahead. "	Short-sightedness and finances.
8	"Rand water might have a specific budget that talks to operations and maintenance but somebody else in Bloem water is not talking the same language and somebody in Brits plant is not talking the same language or somebody else in the municipality doesn't even worry about the budget that must go to the infrastructure."	Finances and communication.
8	"Vacant posts of controllers and then government would come and say, okay, we are going to train a number of graduates and that and that, the municipality will take them over. They will train, after that municipality says, ja, but we don't have money , just extend his [indistinct]."	Human capital, finances, and skills development.
10	"I think there is enough funding in the country but I think it is just the allocation of funding is inappropriate. "	Allocation of funding.

Appendix 9: Future factor coding by individual

Resp.	Quote
1	<p>“I know Namibia has done it, but maybe rather than going into that, okay of course we can release more water by re-using water and make maybe the water from the rivers and from the dam be for domestic purposes and other purposes that require maybe a so-called ultra-pure water. And then where we need to cool and like the power stations, like the mines we use the water that is recycled.”</p> <p>“But we are also failing them there, or failing us, because the quality that they require, because there is also a minimum requirement that they want, the water doesn’t meet that quality requirement, again because of maybe the scale is in a water treatment plant.”</p> <ul style="list-style-type: none"> • Re-use of water could offer future solution to water shortage. FF:Recycle • If the correct quality and volumes could be attained it might lead to dedicated water treatment plants that could recycle waste water to industries. FF:Recycle
2	<p>“Local governments realise that actually smaller local level of better generation is the way to go so you gona have this collegial plague coming out where you have a control centre infrastructure at national level and local is self-reliant and metro’s are getting in more power and are increasing frustrated challenging system and that’s going to start playing out in the water sector as well where it becomes, you going to reach a tipping point where it becomes more viable to go off grid for water but that’s where the income comes from.</p> <ul style="list-style-type: none"> • Water might go the same route as electricity especially in smaller local communities. FF:Offgrid.
3	<p>I can tell you that the water sector is one of the most rigid sectors in South Africa.</p> <p>I can tell you now, because like I told you that South Africa is very politicised. If I take an example, but you know someone once said that I do not know why we are still struggling with operational problems, one country has automated the whole thing. But really we can’t because the labour and unions are going to make so much noise because of the number of jobs that are going to be lost.</p> <ul style="list-style-type: none"> • We might aim to move to an automated future (FF: Automated) but due to the nature politics in the country it will require much more trust and openness around what this means for current jobs. (FF: Trust&Accountability)
9	<p>But they say, okay, without such collaboration we cannot go further, you have to collaborate, you have to start building this kind of collaboration.</p> <ul style="list-style-type: none"> • Within the research and development space one has to collaborate to find better solutions and innovative ideas. FF:IntegratedColoboratedsystem(Innovation).

9	<p>For me the first maybe one of critical issue is again that improvement plan that not only considered the current situation or the solution can help me for this year or the next year, but rather have an adapting plan that can consider the future target that I am looking for. Because, as I said also, we have challenges sometimes that you see when it comes to the budget or finance availability, but still they need to consider such kind of improvement, at the end of the day you need to push to make sure it is approved.</p>
	<ul style="list-style-type: none"> • By having an adaptable plan it will lead to quicker decision making and at the end of the day help reach the end goal or vision. FF: Planning&Goal. FF.Betterdecision making&management.
3	<p>I think it is public participation and communication. I think those are important because those that speak to water conservation, saving water, recycling water, using water wisely and also making people aware that really we are a water scarce country</p>
	<ul style="list-style-type: none"> • Participation and communication is seen as very important for the future water stewardship practises. As well as water conservation and recycling. This section is coded as FF:PublicParticipationAwareness, FF:Recycle; FF:Resourceallocation(Natural&Human)
4	<p>Well I think they are basically all important where the degree of importance might differ but I'm mainly looking at the planning side of things versus the growth.</p>
	<ul style="list-style-type: none"> • If we look at the future growth of demand, the most important aspect according to ND will be proper planning. FF: Planning&Goal.
5	<p>“So een van die baie belangrike dinge wat jy moet onthou en ook dan, in hoë tegnologie word kommunikasie verskriklik belangrik, net om tyd te spaar”</p> <p>“En hulle doen dieselfde werk oor en oor.”</p>
	<ul style="list-style-type: none"> • One of the most import things according to VB is technologies like ICT that will safe time. Especially with regards to research to prevent duplication of projects with the same goals. FF: Technology/Products

Appendix 10: List of Future Factors and share of voice

Number	FUTURE FACTOR	GOV	NGO	PVT SECTOR	RI	WB	TOTAL
1	FF:Technology/Products	11%	19%	10%	22%	4%	16%
2	FF:Better decision making&Management	0%	0%	24%	8%	20%	10%
3	FF:Trust&Accountability	13%	1%	9%	6%	21%	9%
4	FF:IntegratedColloboratedsystem(Innovation)	0%	14%	9%	6%	1%	7%
5	FF:Planing&Goal	1%	6%	0%	10%	2%	6%
6	FF:RevenueCollection&Pricing&ValueofWater	0%	1%	7%	10%	3%	5%
7	FF:Resourceallocation(Natural&Human)	2%	2%	0%	7%	0%	3%
8	FF:FitforPurpose&Reliable	7%	8%	0%	2%	0%	3%
9	FF:ClimateChange&GlobalWarming	7%	5%	4%	1%	3%	3%
10	FF:PublicParticipationAwareness	0%	10%	5%	0%	0%	3%
11	FF:Datacollection	0%	0%	1%	0%	12%	3%
12	FF:Willingnessbuild/Implementation	2%	5%	0%	1%	0%	2%
13	FF:Offgrid	0%	7%	0%	0%	0%	2%

Number	FUTURE FACTOR	GOV	NGO	PVT SECTOR	RI	WB	TOTAL
14	FF:CSR	0%	3%	4%	1%	0%	2%
15	FF:Recycle	4%	0%	0%	1%	3%	1%
16	FF:Security/PreventillegalUse	10%	0%	2%	0%	1%	1%
17	FF:HealthPollutionFree	0%	0%	5%	1%	2%	1%
18	FF:Management&Legislation	6%	0%	0%	0%	3%	1%
19	FF:GreenEconomy	7%	1%	0%	1%	0%	1%
20	FF:Automated	0%	0%	0%	0%	4%	1%
21	FF: FUTUREFACTOR (CATEGORY BIN)	29%	18%	20%	20%	22%	20%

Appendix 11: Future Factor Results for Respective Working Environments

Appendix 11.1: Government

Resp.	Quotes	Key factors identified
11	"The people want free water. We have lost cases around that. Same as free electricity, the by-law will say something but maybe we have not done, again, enough community awareness. Talking about these things in a – our minister challenged us to say, maybe we are talking too technical , find a way of ..."	Changing the language for better public perception
11	"In a very holistic way. All those buildings that are being built, we talk about a green economy , I say water plays a role there. The way these buildings are being done, your public toilets, how much water ...[inaudible]. It sounds like the way the tourism industry, hotels, what they do, all those initiatives that they put in place, why should it not be compulsory also, let it become compulsory."	Green Economy
11	"when you look at the weather patterns ...If it starts raining the possibility of flooding."	Climate change
11	"Appropriate technology within the context of climate change in relation to any infrastructure development that is being – I always used the houses, RDP houses, they must start thinking about the small systems that will take less water, re-use of grey water. We can't continue to have things the way we do. That's why I said, conserving of water in a bigger – in a different way."	Climate change

Appendix 11.2: Non-government organisations

Resp.	Quotes	Key factors identified
2	"But we are not always good at understanding what fit for purpose means, we don't connect to people through the technology"	basic technologies (Fit for purpose)
2	"So the sanitation space is great for innovation, the other space which is my particular passion is green infrastructure where we are very far behind and investing in something like sustainable urban drainage, an alternative which is about managing the catchments"	Green infrastructure

Resp.	Quotes	Key factors identified
2	"You know eco-products and all sorts of things and low-flow taps and I wanted it locally produced and the industry isn't geared for it, particularly the kitchen industry so I mean I cannot believe they, nobody wants me to use local taps."	Eco products
6	"If you regulate business too much they will say, okay, it doesn't make sense for us anymore to come here. On the other hand if you don't regulate them at all, basically speaking the production basis for some of them will be threatened as well"	Collaboration is required, but careful to over regulate when in collaboration.
6	"So that is basically an effort to collect water relevant data in one place, basically I would say setting up a nationwide water information system . In terms of supporting planning at catchment level and there is a lot of modelling[?] going on already but I think that this can even be improved, it can be made more user friendly, it can be made more accessible to different stakeholders, again also to industries"	Water information system will help sharing data.

Appendix 11.3: Private Sector

Resp.	Quotes	Key factors identified
7	"So I think even in Gauteng we also see that problem where you have unserved areas and you now have that competing demand for where should the money go. Should I put it into maintenance where there is already infrastructure there, or should I go and build something new and serve someone who doesn't even have it."	Governance and management is needed to make challenging decisions
7	Yes, for example, going back to pollution, pollution reporting could be done with ICT , so you get normal members of the public reporting hot spots for pollution and so on which could actually go a long way in helping municipalities to monitor pollution . Then you have got more eyes on the ground, and that's a dream because ...	Technology is used to monitor pollution via the help of the public
7	"I think your whole pricing issue – not pricing per se but how you actually work with your free basic water concept and cost recovery becomes a very big element of that. Because the way South Africa is going we are going to start producing[?] massive transfer schemes and if people are not paying some portion of it it will not make the service sustainable	Pricing of water as well start playing a more important role to ensure economic sustainability of infrastructure

Resp.	Quotes	Key factors identified
	at all.”	
7	“It is the value that we ourselves put on water, we don’t see it as being that valuable. ”	Value of water will become more important in the future
5	“And if the person has more information, he can give more information and more information can be generated. And remember, right in the beginning we said that the broader I distribute the decision making , the more people we involve, the better the decision in the end.”	Information will provide building blocks to aid in decision making
5	“So one of the very important aspects that you have to remember, is that in high technology, communication is very important. This will save time. ”	Information and communication save time.

Appendix 11.4: Research institutions

Resp.	Quotes	Key factors identified
3	“So it is a way we want to actually encourage more ICT water research and also try to encourage the uptake of ICT in the water sector, and also facilitate the implementation of some of those ICT and maintenance solutions...”	Promoting uptake of ICT technologies
33	“It’s about how we finding these trans-disciplinary groups and things and get people and start challenging a lot of the ways we have been doing things in the water sector” (talking about the silo approach).	Human resource allocation is important
10	“The city are very interested through the research of government, Research and Development , Research Innovation department with the city, we are interested to create two kind of networks. One of them is water and the other one is a green economy.”	Promote research and development.
10	“I think there is a lot of estimation still, there is lack of resources to take the reading every month for example, some [indistinct] make it clear for you that they mention that for example every three months, the third month they send somebody to take, then the second month estimation and so on.”	Technology solutions will provide more accurate data

Appendix 11.5: Water boards

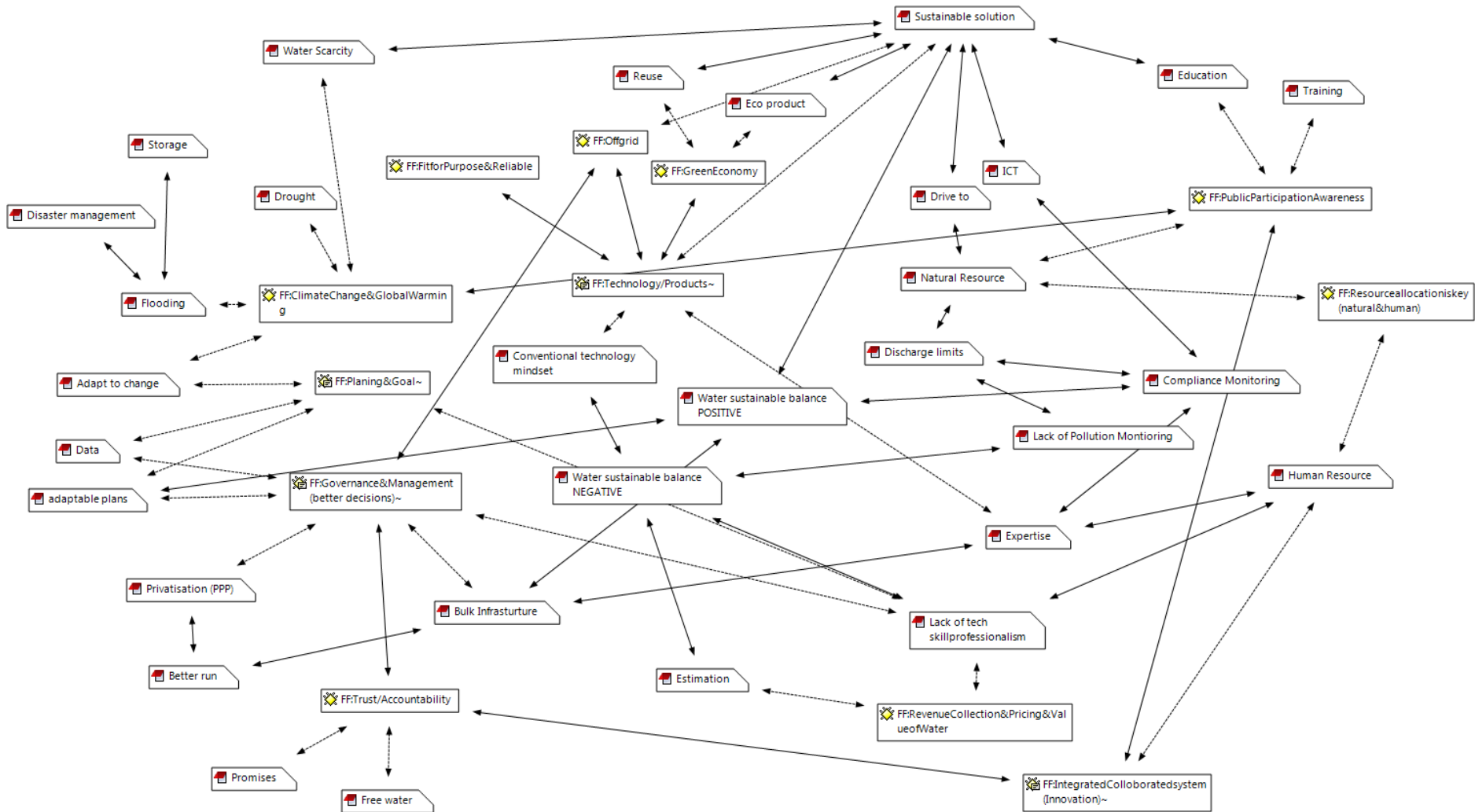
Resp.	Quotes	Key factors identified
1	"Because we are trying to centralise everything, and then they will then despatch it to whoever has complained or who has called, to give him feedback where is his complaint along, or how far are we going to resolve whatever problem they have.	Centralise complaints to provide proper feedback
4	...but yes, so that has been one of the scaredness from the decision makers to say, no, we are going to have a problem on that later.	A restrained to adopt new technologies due to lack of understanding it
8	"If you look at other countries where they have what they call CBO, community based organisations that would basically run these water stewardship and water related issues to make decisions, especially for rural areas, to make decisions about what should we do to preserve this water .	Use CBO to help engage with communities to decide on basic technologies (fit for purpose).
10	I think you have got to take away the bureaucracy and professionalise from the point of view of giving them the authority and accountability to make decisions	Remove bureaucracy to promote governance and accountability.

Appendix 12: ICT factor coding by individual

Resp.	Quote
1	<p>"In fact there is software or an app that was developed by a guy in Durban, instead of them, for example, reading meters as they go. They install sim cards at strategic points and that has got a radius of say about 500 metres. So instead of now a meter reader going to read those meters, that thing sends a signal within that radius, straight into the control room and they download the information and they are able to upload whatever. It stops driving around..."</p> <p>"But if it comes to also the communities, you can create an app which, if it is not already there, whereby if there is a need a person can report the leak wherever he is, he doesn't have to make a call to the service provider."</p> <ul style="list-style-type: none"> Existing Existing software is available to assist connecting devices to simplify day to day operation. It offers more smart and sustainable solutions. (ICT:Smart, ICT:Sustainable) Software could be developed to enable public participation so that cost and time is minimised to report on leaks. (ICT:Opportunities)
1	<p>In fact the sky is the limit when it comes to technology in terms of avoiding pollution of our catchment, because people are doing sometimes deliberately. You find a truck at night dumping something, you do not even know what it is, it could be mercury, it could be cyanide, it could be anything. So if you know that this place is prone to this you can have an instantaneous analyser online there, or even maybe a camera.</p> <ul style="list-style-type: none"> Faster response time in catching polluters while protecting the public. (ICT:Protect) ICT opportunities in protecting us. (ICT:Protect, ICT:Opportunities)
2	<p>"I think cost is definitely a prohibitive factor but I think that needs to be into the price, water pricing as well so that, it's like electricity I think we will start seeing the tipping point where some of these technologies become more affordable because of the cost of water but also there is, we start creating industries around producing these water-saving technologies. We almost where there is a market demand for them so we will create the industry from there. So that I think is something we going to see happening and it will start getting smarter housing systems."</p> <ul style="list-style-type: none"> The value of water could increase to overcome the cost of technology. (ICT:Challenges) The demand that will push for smarter housing systems. (ICT:Opportunities, ICT:Smart)
3	<p>"So if [indistinct] models can look at integrating all the services into the one, then probably that could work, because at the moment it is very difficult to have a separate ICT system for water, and have a separate ICT system for health, and a separate ICT system for fees collection."</p> <ul style="list-style-type: none"> KN was referring to obtaining one integrated and collaborated system. (ICT:Opportunities, FF:IntegratedCollaboratedSystem)
4	<p>"In a plant where you used to have about three or four people that are operating in there, that plant is automated and then it runs by itself and you do not need those</p>

Resp.	Quote
	<p>guys.”</p> <ul style="list-style-type: none"> • The perception of potential job losses prohibits the implementation of ICT. (ICT:Challenges).
6	<p>““Ideally information is shared freely, but we also know that there are limits, especially working with the private sector because they are concerned about competition and competitors knowing what, and also about government using that information against them, we as regulators, but that is why that is a shared information system that then everybody can contribute data to build a joint understanding of the water situation in certain catchments.”</p> <ul style="list-style-type: none"> • Using data obtained through ICT systems against other companies. (ICT:Share and ICT:Challenges)
8	<p>“..“..you cannot take ICT out from sustainability of our environment. The models that the guys are doing do need ICT, we need ICT if we need to warn you, whether it is your weather patterns, whether it is your flows, whether you need info from people, you need ICT. “</p> <ul style="list-style-type: none"> • Caring for the environment is all about sustainability. (ICT:Sustainability) • New models and systems require ICT. (ICT:Opportunities) • Sharing information helps make society more inclusive. (ICT:Share)
10	<p>“I think it is the risk associated and especially hacking and loss of control, people feel they are not in control anymore ...”</p> <p>“But if you were to think of it it could be a major security risk if somebody were to take over the water supplies and suddenly shut off the dams or the supply to a city by hacking into it”</p> <ul style="list-style-type: none"> • ICT systems may fall prey to hackers. ICT:Challenges. • Issue of water security and control that comes with the risk of hacking. ICT:Security.

Appendix 14: Future Factor Network view.



Appendix 15: Ethical clearance.

Dear Coenraad Loubser

Protocol Number: **Temp2016-01033**

Title: **LEVERAGING CYBER PHYSICAL SYSTEM FOR EFFECTIVE WATER STEWARDSHIP: PROBING THE FUTURE PREPAREDNESS OF WATER SERVICE AUTHORITIES**

Please be advised that your application for Ethical Clearance has been APPROVED.

You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

Adele Bekker