Identifying Socio-Cultural Determinants to Access: Implications for e-Governance in the Water & Sanitation Sector

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Dissertation submitted in fulfillment of the requirement for the award of Master of Philosophy in Information Systems.

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Acknowledgments

I would like to thank my supervisor, Ulrike Rivett, whose encouragement and good humour has made my time at the University of Cape Town gratifying and rewarding. When I began at UCT, I felt lost and without direction. However, under her guidance I have accomplished things I never thought would be possible and am a more confident person because of it.

I would like to thank Shamiso Kumbirai and Tasneem Ebrahim for the hours they put in helping me to conduct interviews. Despite the early mornings, long days, inclement weather, and difficult conditions, they were always kind and supportive of my work.

I would like to thank Naomi Ncayiyana and Michal Singer for making me feel at home in South Africa, as well as the people of Imizamo Yethu, whose endurance in the face of hardship is both tragic and inspiring. Without their openness and generosity, this project would never have been possible.

Last and most importantly, I would like to thank my partner, Benjamin Taylor, for his never-ending patience and support while I've been overseas pursuing a master's degree.

Abstract

This study identifies socio-cultural determinants to both access to technology, as well as access to water and sanitation services, to build an understanding of how technology use and service delivery interact to either restrict or empower groups to communicate their water and sanitation needs through e-government platforms. Even though South Africa's racist apartheid laws were repealed over two decades ago, water and sanitation services in predominantly black areas of Cape Town are still effected by the structural inequalities rooted in apartheid policies. Frustration over the state of water and sanitation services in these areas frequently erupts into violent and destructive protests. A key piece to reducing these inequalities lies in the city's ability to collect data on the state of water and sanitation infrastructure, and the City of Cape Town has promoted a number of e-Governance initiatives to streamline the process of collecting information from users of water and sanitation services. Among these initiatives is an SMS based fault reporting system, which was envisioned as an inexpensive method for users to easily report service failures to the city. Additionally, the city has adopted other web-based reporting platforms based on popular social media sites and email, which can be accessed using internet enabled mobile phones. However, despite high rates of mobile phone ownership in Cape Town, little is known about how people use them.

It is important to know how people use mobile phones in order to gauge whether e-Governance initiatives are accessible to poor and vulnerable populations. This analysis is particularly important for highly stratified societies such as South Africa, since it has been shown that introducing ICT into a service delivery system will not result in social change, but will simply act to amplify the underlying intents and capacities that are already present in the system. The purpose of this study was to identify socio-cultural determinants to water and sanitation access and ICT use, to gauge the capacity of groups with marginal access to water and sanitation services to advocate for improvements using mobile phone enabled fault reporting. The study was carried out as a cross-sectional analysis using chi-square tests to identify correlations between socio-cultural data that was collected during three days of interviews in the township of Imizamo Yethu. A spatial analysis was also employed to visualise geographic patterns of access to water and mobile technology. The results indicate that mobility challenged township residents face barriers to accessing water and sanitation services, and also have limited options for reporting faults using mobile phones. Additional disparities in access to services and mobile phone use were found to be based on geography, economic ability, education, as well as place of birth (foreign born vs. South African born).

The results indicate that marginalised segments of the population have very limited capacity to communicate their needs to the municipal government. Therefore it seems that e-Governance in the water and sanitation sector likely perpetuates some of the existing inequalities. Hopefully the information and recommendations brought forward in this study will prove helpful to those working to undo the social fractures caused by decades of exclusionary policies.

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Abbreviations

e-Government – Electronic Government
e-services – electronic services
ICT – Information and Communication Technology
ICT4D – Information and Communication Technology for Development
LGBT – Lesbian, Gay, Bisexual, and Transsexual
SAPS – South African Police Service
SJC – Social Justice Coalition
UN – United Nations
USD – United States Dollar

1.0 Introduction

1.1.0 Overview

The rapid spread of information and communication technologies (ICT), particularly mobile phones, has changed the way citizens and governments interact. Public participation, advocacy, communication, and service delivery increasingly take place through digital mediums such as social media, SMS, and the internet. These changes are reflected in the ICT based platforms adopted by the City of Cape Town in South Africa for sharing and receiving information with citizens, such as the city's fault reporting systems for the water and sanitation sector. These web based and SMS based fault reporting platforms allow citizens to report issues related to water and sanitation services without visiting government offices in person, or calling the municipality's fault reporting line, which is often congested with callers.

It must be acknowledged that access to water and sanitation services in Cape Town is highly unequal. Even though apartheid policies have been abolished for over twenty years, inequalities in water and sanitation services still reflect the racist and classist divisions of that era. Because of this, the City of Cape Town is not easily categorized as city belonging to the global north or south, as it exhibits characteristics commonly associated with both. Predominantly white areas benefit from world-class services, while black African townships make do with outdated and overburdened infrastructure. Frustration over the poor quality of service delivery in the townships often results in destructive and sometimes violent protests, such as the famous 2013 'poo protests', during which large volume of human waste were dumped inside Cape Town International Airport, provincial government offices, and onto one of the country's busiest highways to draw attention to the state of sanitation services in poor communities (Prince, 2013). The City of Cape Town, which expanded its e-Governance initiatives in the water and sanitation sector as a means to reduce unequal access to services,

assumes that e-governance platforms, particularly its SMS based fault-reporting system, are more or less universally accessible due to the high rate of mobile phone ownership in the municipality (City of Cape Town, 2009). However, phone ownership does not necessarily result in people using the system since socio-cultural factors drastically shape how and why people use mobile phones.

This empirical study identifies some of the socio-cultural factors that shape access to water, sanitation and mobile phones in Cape Town to determine if the segments of society who bear the brunt of service delivery failures, have the technological capacity to communicate their needs using mobile phone enabled fault reporting systems. The results of the study shine light on the limitations of e-government platforms to reduce inequality, and highlights factors which shape access to essential services within low-income, racially homogenous black African townships.

1.2.0 Key Concepts

Access - Access is defined as the physical availability of an amenity combined with the capacity to make use of it in a meaningful way (Selwyn, 2004).

Socio-cultural traits– Socio-cultural traits are locally embedded characteristics that determine an individual's social capital within a network of interconnected individuals and organizations. Social capital within this network allows groups, and members of these groups, to obtain certain privileges or deny privileges to groups with less capital (Thornton, et al. 2011).

Coloured - a person of mixed European ("white") and African ("black") or Asian ancestry, as officially defined by the South African government from 1950 to 1991 (Britannica, 2014).

1.3.0 Research Question and Aims of Study

In the context of this study, the relationship between mobile phone use and access to water and sanitation services form the basis for answering the question:

Is there a relationship between the ICT use of groups defined by shared socio-cultural traits, and their ability to access essential services?

The aim was to identify socio-cultural traits that shape access to water and sanitation services, as well as mobile technologies, in an attempt to understand if populations who are marginalised in terms of access to services have the technological capacity to advocate for improvements using the City of Cape Town's mobile phone enabled fault reporting systems. This is important given that the municipality's water and sanitation services are characterised by unacceptable levels of inequality, and the introduction of ICT into the system is likely to amplify existing inequalities if barriers to accessing ICT mirror barriers to accessing water and sanitation services.

The reason that socio-cultural determinants to ICT use should be considered in relation to an e-governance initiative is clearly expressed by Bélanger (2009) who states:

> Government agencies have a charge to make their information and services available to everyone. However, the uneven distribution of computer access and skills biases the governments' ability to make their online services equally accessible and beneficial. As a result, adoption of e-government is limited to those who have access to the technology and possess the skills necessary to utilise e-services. By providing electronic services to a select group of people government agencies miss the opportunity to interact with and solicit feedback from a larger portion of the population. Hence it is imperative for government agencies to identify

> which demographic groups are being excluded from this innovation and then implement policies to encourage inclusion.

1.4.0 Ethical Position

Each person in South Africa is constitutionally guaranteed a minimum daily allotment of 25 litres of safe, clean water; and while the constitution does not explicitly state that the government has an obligation to provide access to sanitation, the 2001 "White Paper on Basic Household Sanitation" states that the government has an obligation to ensure all people have basic access to sanitation (Tissington, 2011). Despite the government's obligation to provide services to poor communities, the South African Human Rights Commission (2014) states that many people are still unable to meet their minimum water needs and live without reasonable access to toilets.

According to Tissington (2011),

> Access to adequate sanitation is fundamental to personal dignity and security, social and psychological well-being, public health, poverty reduction, gender equality, economic development and environmental sustainability.

Because adequate access to water and sanitation are basic prerequisites for human wellbeing, it is important that e-Government initiatives aimed at improving essential services be useful and accessible to poor and marginalised populations.

1.4.1 Ethics Approval to Conduct Study

During this study, data was collected on socio-cultural traits, mobile technology use, and water and sanitation access. Analyses were carried out to determine if and how these factors correlate with one another in ways that could hamper respondents' ability to access water and sanitation services or participate in the management of services. No personal identification data was collected from participants. Verbal consent was obtained before proceeding with interviews, and interviews were only conducted with township residents age 16 years or older to avoid ethical conflicts regarding the ability of children to give consent. Ethics approval was obtained from the Faculty of Engineering and the Built Environment at the University of Cape Town. The signed ethical clearance, as well as the questionnaire used in the study, can be found in the appendix.

2.0 Literature Review

2.1.0 Background

Information and communication technologies have become an integral component to the functioning of modern society. According to Castells (2011), toward the end of the last century there was a realignment of social, technological, economic, and cultural transformations that gave rise to a new form of society known as the Network Society. This Network Society is characterised by the almost instantaneous flow and exchange of information, capital, and cultural communication (Castells, 2011). The 'digital divide' is a commonly used term to refer to the gap between those who are empowered in the Network Society and those who live on its margins. This divide mirrors a broader context of international social and economic relations in which wealthy Northern economies form the centre, while poor countries exist at the periphery (Chen & Wellman, 2004). Digital divides also exist within societies due to socio-cultural factors such as education gaps, income inequality, and place of residence (Chen & Wellman, 2004; Chinn & Fairlie 2004). While these divides are present within all societies, they are especially prominent and problematic in the Global South, where a lack of skills and hardware marginalises large populations in a global system that increasingly demands ICT as a medium for civic participation, education, employment, and cultural exchange (Chenn & Wellman, 2004).

Due to the relative scarcity of studies focusing on ICT use in the Global South, Northern studies are also included in the literature review. The selected studies from the North were deemed appropriate for inclusion, due to the fact that they address issues such as gendered and intergenerational digital divides, which are not relegated to any particular region of the world. Furthermore, including studies from both the Global North and South speaks to the reality that South Africa, and especially Cape Town, are not easily categorized as Northern or Southern, since this region exhibits many Northern characteristics, such as a highly developed (but unevenly distributed) infrastructure, robust civil society,

and a diversified economy. However, Cape Town clearly suffers from many issues typically associated with the Global South, including high unemployment, widespread poverty, high rates of violent crime, and high rates of HIV/AIDS infection.

Access to information and communication channels form the foundation of the Network Society, so institutions as well as political and social movements have been forced to develop strong relationships with ICT or risk losing relevance and influence in society (Castells, 2011). Since power is derived from the ability to influence thought, opinion, and behavior through the use of these technologies (Castells, 2011; Castells, 2007; Van Dijk, 2006), it is necessary to examine who in the City of Cape Town has the capacity to leverage them. By looking at the ability of groups to participate in ICT based fault reporting, we shine light on a real world example of how digital tools amplify or marginalise certain voices in the discourse on service delivery management.

2.2.0 Socio-Cultural Digital Divides

Physical access to ICT can be determined by where a person lives due to geographically specific factors, such as local telecommunications policy and infrastructure (Chenn & Wellman, 2004; Chinn & Fairlie 2004). In developing countries, these factors manifest in wealthy urban areas having better infrastructure than rural and poor urban areas (Olatokun, 2007; Chenn & Wellman, 2004; Chinn & Fairlie 2004; Graham, 2002). Even among users with physical access to technology, their technological capacity is dependent on acquiring and developing the skills needed to utilise ICT, which can be constrained by a number of factors including education, language, and gender (Geldof, 2011; Chenn & Wellman, 2004; Chinn & Fairlie 2004; Warschauer, 2002; Raji, et al., 2006). The following sections will focus on how specific socio-cultural factors – geographic location, gender, age, disability, stigmatisation and poverty – have been shown to shape access to, and use of, ICTs.

2.2.1 Geography

The social and economic cores and peripheries of the global information 'age', rather than being continents apart, now often lie geographically adjacent to each other within individual cities. Often, they are literally a few feet apart, separated by gates, walls and highly uneven access patterns to the crucial portals that support participation in electronic domains.

-Stephen Graham, 2001

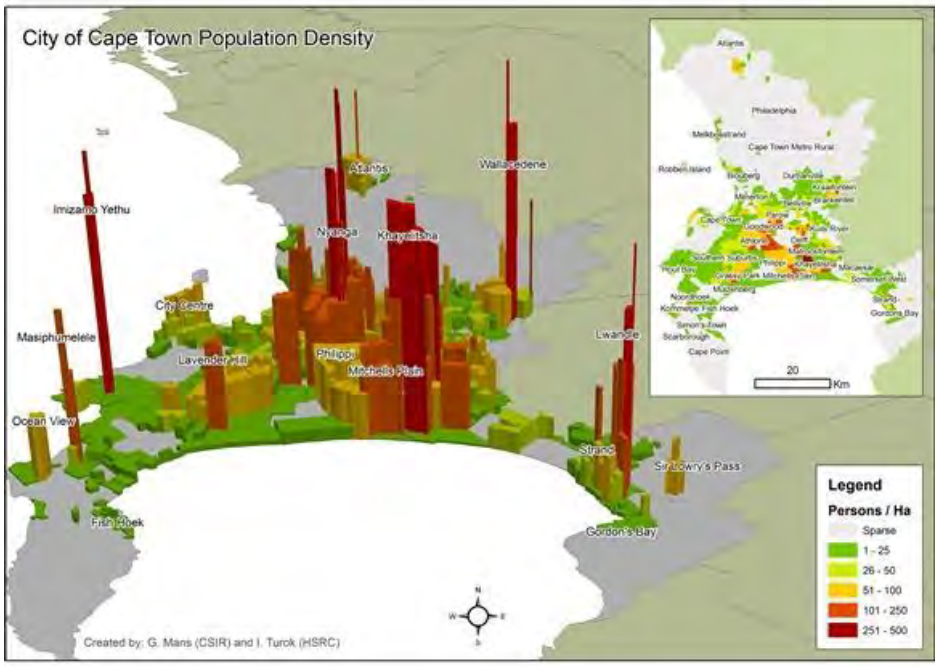
Geography affects access to ICTs in myriad ways, there exist technological urban biases, which encourage the concentration of ICT related infrastructure in cities. A study of ICT access in Nepal highlights how urban bias has moved the capital, Kathmandu, closer to the centre of the Network Society, while leaving people in rural areas without the means to access and use ICT (Thapa & Saebo, 2007). Within Nepal, Kathmandu accounts for around two-thirds of the country's telephones despite 85% of the country's population living in rural areas. The city has a teledensity of 15 telephones per hundred urban Nepalis, compared to less than one per hundred rural Nepalis (Thapa & Saebo, 2007). Beyond the lack of infrastructural support for ICT access, there is a lack of technical know-how to maintain sophisticated equipment in rural communities (Thapa & Saebo, 2007).

While urban areas tend to have an advantage over rural regions in terms of infrastructure, economic disparities within cities mean many poor urbanites do not enjoy access to ICT. According to Graham (2002) the uneven societal distribution of ICT is most visible in cities where clusters and enclaves of 'information elites' are often squeezed up against the disconnected masses. Many cities of the South, such as Bangalore, have made great strides in joining the Network Society, and are seen as centres of ICT innovation. However, the world class infrastructure of these Southern tech hubs exists to serve the needs of the elite, rather than the development needs of the poor majority (Graham, 2002).

An example of the disparities between Southern information elites and the

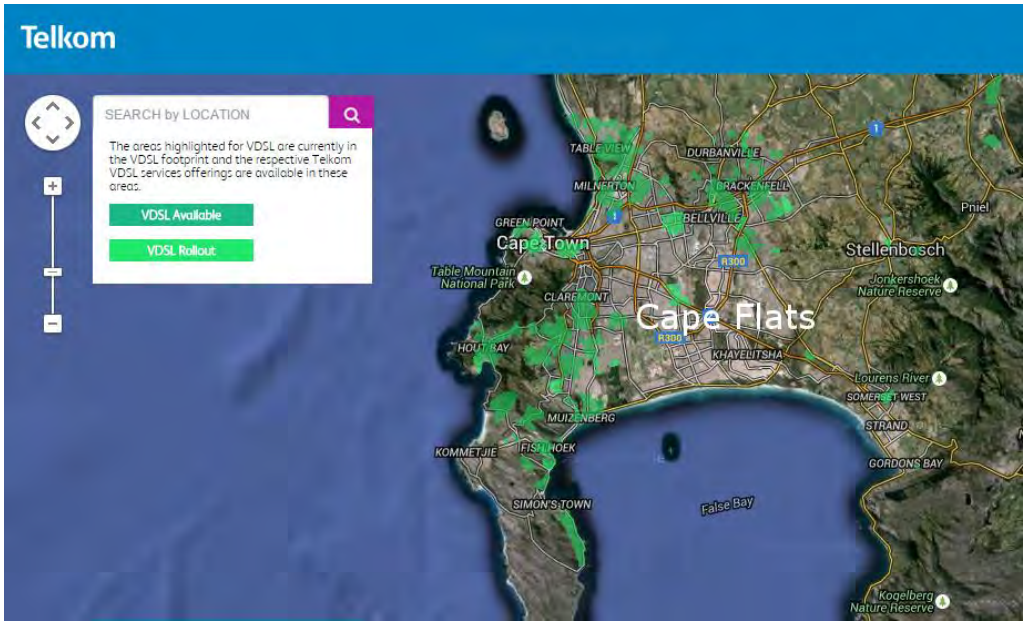
disconnected majority can be seen in Nairobi, where construction is underway on Konza Techno City. Dubbed the 'Silicon Savannah', this purpose built city is designed to offer unparalleled access to ICT infrastructure, and was initially planned to be a centre for IT and IT-enabled services. However, the scope was expanded to include high-end commercial, recreational, and residential venues, complete with its own water, electric, and transportation systems (Konza Techno City, 2012). The quality of services and infrastructure planned for Konza stands in contrast those available to the majority of Nairobi's population. For instance, Kibera, a slum that contains 60% of the city's population, has no all-weather roads and the majority of residents lack access to electricity and telecommunication services (Morawczynski, 2008).

Clearly, geographic location acts as a determining factor to ICT access; this takes place on a transnational scale, as in the case of Global North vs. Global South, on a national level, and even on the local level, where super-connected enclaves exist within comparatively disconnected metropolitan areas. Not surprisingly, given that Cape Town is one the world's most economically disparate cities (Valentine, 2004), these intra-urban digital divides are clearly evident between wealthy, highly developed suburbs, and the under-resourced townships, which house the majority of the population. Map 1, which was created by Gerbrand Mans and Ivan Turok (2011) using data from the 2011 census, clearly shows that the municipality's population is concentrated in and around the townships of Khayalitsha and Nyanga.



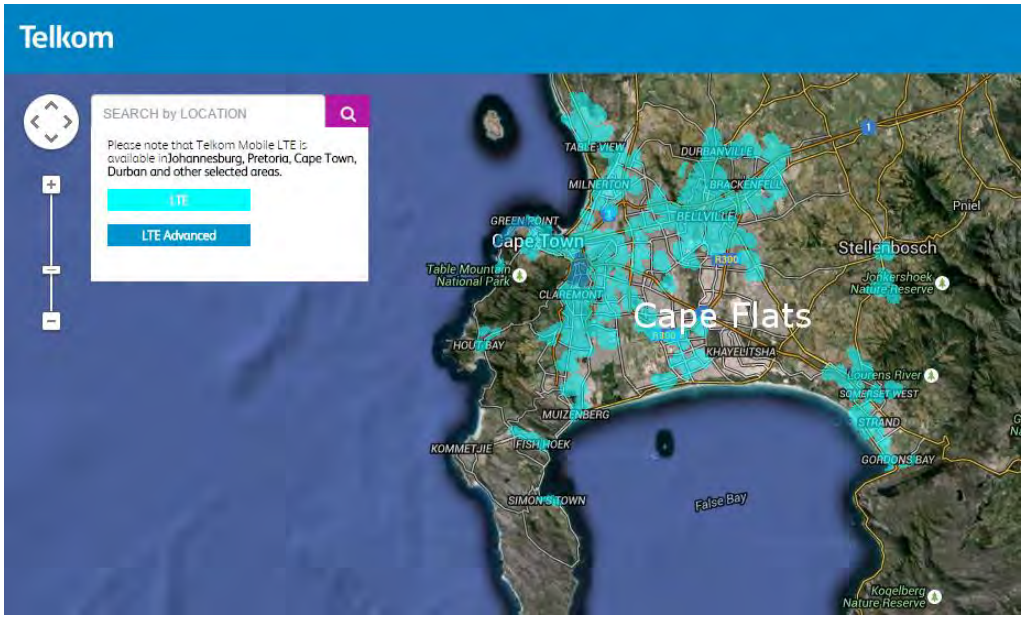
Map 1. Population Density in Cape Town. © Gerbrand Mans, Ivan Turok and the South African Cities Network

Despite the fact that most of Cape Town's population resides in these areas, the city's telecommunications infrastructure is most developed in the wealthier central city and surrounding suburbs. As Map 2 shows, Very-high-bit-rate digital subscriber line (VDSL) services are available almost exclusively in the in the city centre, and in the comparatively wealthy, areas to the north and south of the CBD.



Map 2. Availability of VDSL in Cape Town. © Telkom

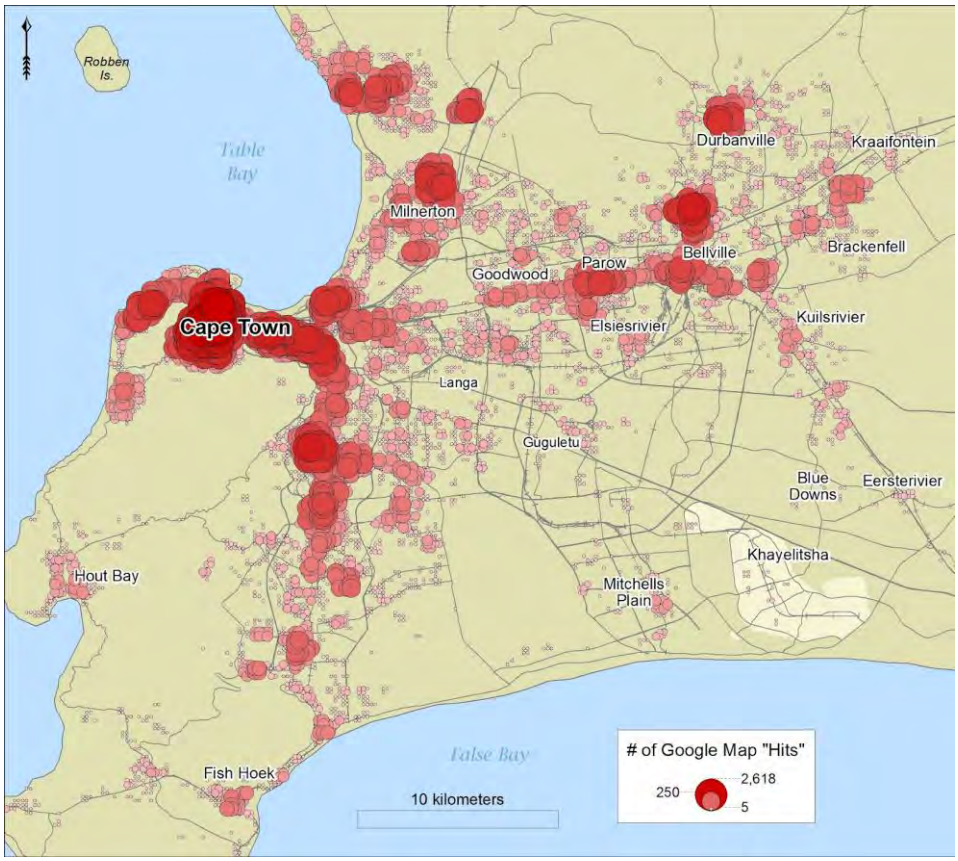
The only part of the Cape Flats that is covered by Telkom's VDSL networks is Cape Town International Airport and the areas immediately adjacent to it. Disparities in infrastructure are not just limited to wired technologies, but extend into the wireless realm too. Map 3 shows that the Cape Flats is also largely not covered by Telkom's Long Term Evolution (LTE) wireless broadband network.



Map 3. Availability of LTE and LTE Advanced services in Cape Town. © Telkom

The digital divides within the municipality present real barriers to knowledge

sharing, which is highlighted by Levy (2012) who, by mapping the amount of geo-located material in Google Maps (Map 4), shows that essentially no information is uploaded from Cape Town's most populous areas. While the lack of geo-located information on Google Maps, in and of itself, may not be cause for much alarm, the implication that data is not being transferred out of the municipality's most populous areas, not to mention the areas where most service delivery protests originate, should raise some concern among those responsible for managing Cape Town's service delivery systems. It is not unreasonable to assume that if digital divides prevent Google from collecting data, than they also limit the information available to the municipality on the state of its water and sanitation systems.



Map 4. Google Map Hits in Cape Town. Created by Jeff Levy (2012)

2.2.2 Gender

I don't like earphones. When you are using them, people will laugh at you at home. Because at home these are only used by boys and not by girls.

-Malawian Girl (Quoted by Geldof), 2011

Another socio-cultural factor, which has been shown to shape access to technology, is gender. It has been noted that women, particularly in the Global South, are more burdened by domestic responsibilities than men. Women and girls are often expected to occupy their time with housekeeping activities, limiting their exposure to ICTs found outside the home, as well as their ability to attend school where they could learn the social and cognitive skills needed to participate in the Network Society (Huyer & Mitter, 2003, Geldof, 2011, Olatokun, 2007). Furthermore, because women in the Global South are less likely to live in urban areas than men, they are more acutely affected by low rates of ICT infrastructure in rural areas (Huyer & Mitter, 2003, Olatokun, 2007). Even when women live in areas connected to ICT networks, if the local cultural norms prevent the social mixing of the sexes, women and girls may be discouraged from visiting public venues where technology can be accessed and used, such as libraries, cyber cafes, and telecentres, if these spaces are staffed by men (Terry & Gomez, 2010). Restrictive social norms not only prevent physical access to technology, they can also restrict women's ability to receive and transmit vital information.

Dodson, et al. (2013) noted,

> In rural Muslim-Berber areas [of Morocco], conservative traditional and religious values limit communication between unrelated women and men. These restrictions persist despite the device. Limitations on communication between unrelated women and men extend beyond face-to-face interactions to encompass the virtual, digital and electronic spheres.

While the aforementioned studies focus on gendered digital divides in less-

developed countries, gendered access to technology is not a phenomenon unique to the Global South. For instance, worldwide, most early adopters of the internet were men. Even into the first decade of the twentieth century women made up less than half of web users in all countries except the USA and Canada; in Germany, Italy, France, Switzerland, and Belgium women still made up less than 40% of internet users in the year 2002 (Hafkin & Huyer, 2007). Similarly, a 2003 report on the City of Cape Town's public internet access program, known as Smart Cape, found that only 21% of users accessing the internet at Smart Cape access points were women (Infornomics, 2003). Tough it is commonly accepted that the gendered internet access gap is closing in the Global North, gender related social inequalities continue to perpetuate digital divides in the Global South (Hilbert, 2011). Furthermore, despite the gains made in getting Northern women online, they are still underrepresented in ICT related professions, as well as university ICT courses (Crump, et al., 2007).

The root of gendered ICT access gaps is succinctly explained by Geldof (2011), who states, "ICT use is a social practice that can only be understood in the social context in which it takes place." A particular challenge in addressing gendered digital divides is that technologies are predominantly developed by men in Western societies, who have little or no understanding of the social, economic, or cultural contexts in which these technologies are expected to be used (Best & Maier, 2007). This results in technologies and infrastructure that is inherently biased toward the needs and aspirations of men, thus affording them a disproportionately amplified voice in the Network Society. This is particularly true in the Global South where gender disparities in employment, domestic responsibilities, self-determination, and education enhance women's disconnection to ICT.

2.2.3 Education

Research indicates that access to a formal education has a positive impact on access to ICT. Higher education is found to be associated with the use of communication and information services, such as email and online banking, as well as searching for financial, political, and government information (Howard, et al., 2001; Bonfadelli, 2002). Inversely, lower levels of education have been found to be associated with the use of technology primarily for entertainment purposes. While studies from the Global North often emphasise gaps between those who have a university education and those who do not, research on low-literate populations in South Africa, the Philippines, and India shows evidence of a fundamental cognitive change that occurs somewhere around grade six in a K-12 education system, which empowers users to navigate moderately complex mobile phone and computer user interfaces (Medhi, et al., 2010), thus suggesting that basic technological capacity is intrinsically linked to basic education. Though they have not been able to identify the exact cognitive skills that allow for this navigation, they have shown that it applies even to non-textual hierarchical user interfaces, indicating that barriers confronting non-literate and low-literate users extends deeper than their inability to comprehend written language (Medhi, et al. 2013).

Commonly, illiterate and low-literate users depend on more educated acquaintances to act as intermediaries to help them use technology and decipher content. Intermediaries play an important role in transferring technological benefits among a network of people, who otherwise may have no ability to use ICT (Bailey, 2009; Nithya, et al. 2010). Yet, a dependence on intermediaries puts low-literate users in a vulnerable position, as they must sacrifice privacy in order to access information (Nithya, et al. 2010). Intermediaries also act as gate keepers to information, whose own biases can influence the mobile activities they are willing to assist with, as well as the information they are willing to impart (Bagdikian, 2004; Livingston & Bennet, 2003). Furthermore, an intermediary's ability to accurately translate information into an oral format is

directly dependent on their interpersonal communication skills and ability to comprehend the information they interpret. Therefore, intermediary dependent users are at high risk of receiving flawed information (Nithya, 2009).

Hilbert (2011) further points to the importance of formal education on users' ability to effectively use ICT. His study analysed gendered digital divides in twenty-five Latin American and African countries, and found that despite very significant differences in male and female use of the internet, these gaps were eliminated when comparing men and women who had equal access to educational and employment opportunities. Geldof (2011) also found that cultural beliefs against educating girls made it difficult for women in rural Ethiopia and Malawi to learn the skills necessary for participation in the Network Society. Additionally, she also found that people in her study area, regardless of gender, held strong perceptions that ICT were only meant for the educated and literate. This belief was strengthened by the predominance of English language advertising for ICT services and technologies, as well as the prevalence of English in online spaces. The English language is taught in both Malawian and Ethiopian schools, and therefore is seen as a marker of educational attainment (Geldof, 2011). Those who have not had the opportunity to study would therefore be less familiar with English, which would act to discourage the use of ICT. Inadequate access to education and training were also found to be among the primary factors inhibiting the dispersion of ICTs in India (Bartolome, 2014), as well as in South Africa's Western Cape Province, where a study of ICT use among farm workers revealed that higher levels of formal education translated to more ICT use (Tembo, et al., 2010).

2.2.4 Age & Disability

Due to their reduced perceptual and cognitive abilities, older adults often experience more difficulties in learning computer software, and navigating, browsing, searching for, and retrieving information on the World Wide Web.

-Bo Xie, 2003

Despite a general lack of published studies on the impact that age and disability have on ICT use in the global south, there are some northern studies that shed light on intergenerational digital divides, as well as barriers to technology use experienced by people with disabilities. Because of the lack of studies focusing on this topic, Neves, et al. (2013), who conducted a very in depth examination of ICT use among Portuguese adults between 65 and 74 years old, account for the bulk of the literature reviewed on the topic. Their study revealed that age correlates negatively with ICT access and use. The study of revealed that 66% of Portuguese households had at least one computer in 2012, while 61% had access to the internet at home. However, only 14% of Portuguese adults between 65 and 74 years of age used a computer, and just 12.5% of the same group were Internet users. The elderly of Portugal were also found to be the age group that used mobile phones the least, and were the only age group whose landline use was higher than mobile phone use (Neves, et al. 2013).

Neves, et al. (2013) explains that the age based digital divide is based primarily on attitudinal and functional factors. They found that only a small fraction of the study population owned a personal computer, and just around one in ten had access to the Internet. Though respondents generally had a positive view of computers and the internet, believing them to be useful tools, some commonly cited reasons for not using them included: not knowing how to use them, no need to use them, cost, and the perception that they are primarily for young people. A few respondents did use some internet features, such as Skype, but required the help of relatives to get the programs running. While only a small minority of participants had access to computers or the Internet, over three-quarters owned mobile phones, which were primarily used to communicate with family, friends, or for use in emergencies. It was reported that mobile phones were generally well received, even by those who did not own them, but some participants could not afford a mobile phone or did not feel they could use one. While most participants did own mobile phones, a lack of digital literacy meant that they were only used for basic functions, such as making or receiving calls.

A study of adults aged 60 years and older in the United States and Israel found that ICT use among this population has increased over the past decade. However, much like the Portuguese cohort, older Americans and Israelis often need assistance to fully utilise ICT (Heart & Kalderon, 2013). Age is also is a factor contributing to ICT use among farm employees in South Africa's Western Cape Province, where younger employees were observed to use ICTs more regularly than older employees (Tembo, et al., 2010). Unfortunately, there does not appear to be any current research on the impact of age and disability on ICT use specific to the City of Cape Town. However, a 2002 survey found that only 17% of Capetonians over the age of 55 had ever used a computer, compared to 32% of those between the ages of 46 and 55 (Infornomics, 2003). The same survey found that only 20% of respondents with a disability had ever used a computer, compared to 31% of those who were not disabled. Though the data is out of date, it does show that these variables have significantly impacted access to ICT in the City; providing a rational reason to analyse the current impact these variables have in shaping access to technology.

Reasons older people and people with disabilities may have difficulties adopting new technologies are because ICTs are typically not designed to accommodate impairments related to vision, perception, motor skills, and cognitive abilities. These challenges could be mitigated through design and age appropriate training materials (Xie, 2003), but according to Xie (2003), improved design and training can only do so much to close the digital divide between younger and older adults. He suggests that mobility issues limit the ability of disabled adults, who account for a large portion of the elderly, from accessing public ICT facilities.

2.2.5 Income

Information access and socio-economic status are inextricably linked, which is reflected in access to ICT (Chen & Wellman, 2004; Chinn & Fairlie, 2006; Graham, 2002). The expense required to obtain ICTs and related services such as data and talk-time, limit the poor's ability to obtain newer and better technologies. It

has been observed that new technologies do not diffuse haphazardly into society; rather, they diffuse systematically as a vertical movement along the socio-economic strata, percolating down from the highest to the lowest rungs of society (Korupp & Szydlik, 2005). This principal is highlighted by Perrin and Duggan (2015), who state that overall 84% percent of Americans have access to the internet, yet only 74% of Americans with an annual household income of USD 30,000 or less are online. While internet access among this economic cohort has increased from just 54% in 2008, most of that growth resulted from the adoption of internet enabled smartphones (Perrin and Duggan, 2015; Smith, 2015). This has led to a new income based divide in which 13% of low-income American internet users are dependent on smartphones for internet access, compared to just 1% of high-income users. Within the Global South there is evidence that mobile dependent internet access negatively impacts users' engagement with mobile devices. Zainudeen and Ratnadiwakara (2011) found that among mobile phone users earning less than USD 2 per day, in six Asian countries, the use of more-than-voice services such as mobile banking, is 600% higher among those who have access to an internet connected computer, in addition to their internet connected phone.

Furthermore, Smith (2015) found that 48% of smartphone dependent users have had to cancel or suspend service for a period of time due to financial hardship. Additionally, 30% of smartphone dependent Americans claim to frequently reach the maximum amount of data available on their plan (Smith, 2015). This indicates that even though internet access has increased among the American poor, their access is insecure, and qualitatively different than the access enjoyed by the wealthy. Because the wealthy are able access the newest and most advanced ICT, an inherent advantage in the Network Society is created, which reinforces and strengthens their social status (Graham, 2002; Van Dijk, 2006). Evidence of this is shown by Bélanger and Carter (2009) who found that income was a major predictor of participation in e-Governance programs in the American state of Virginia. They state that income has a direct effect on physical access to technology, which limits opportunities for the poor to access online government services. These findings are particularly relevant in the context of

Cape Town, where e-governance has been promoted as a tool to improve access to services.

2.2.6 Stigmatisation

Displaying a stigmatised characteristic or being associated with a stimatised group has been shown to impact the way people engage with technology (Garofalo, et al., 2007; Maya, 2010; Chaiyajit & Walsh, 2012). Stigmatisation is defined as the regarding of a characteristic or group of people in a way that shows strong disapproval (Marriam-Webster, 2015).

According to de Albuquerque (2011):

> Stigma can broadly be understood as a process of dehumanizing, degrading, discrediting and devaluing people in certain population groups (…) there is a perception that the person with the stigma is not quite human. Stigma attaches itself to an attribute, quality or identity that is regarded as inferior or abnormal.

Research indicates that stigmatised populations often have unique technological habits that differ from mainstream population. Research by Garofolo, et al. (2007) suggests that this stems from these populations using ICT as a tool to bypass hostilities and prejudice which hinder their ability to socialise, and fully participate in society. For instance, their study of LGBT teens, who due to the stigma associated with their sexual or gender orientation found it difficult to form relationships or build social networks, found that the perceived safety and anonymity of the internet encourages them to gather in online communities where they can freely pursue interests and engage peers with similar experiences (Garofalo, et al., 2007). Eagan (2000) also reports on the online habits of LGBT teens, and states that they often develop systems of passwords,

aliases, and encryption to protect their anonymity and privacy, since being identified as a sexual or gender minority could have dire consequences to their wellbeing and safety.

Another study of stigmatised poulations found that ICT is used to facilitate socialising, access to public health and legal information, and counseling services among transgendered individuals in Thailand, who have historically faced obstacles to community building and access to social services because of the stigma associated with their gender identity (Chaiyajit & Walsh, 2012). Similarly, research on ICT use among Indian men who have sex with men explains that a complex system of Bluetooth enabled geolocation and data sharing allows same-sex attracted men to use smartphones as a tool to find partners, allowing them to safely circumvent social norms that prohibit romantic same-sex relationships (Maya, 2010). Much like what was observed among the Thai transgender population, people with stigmatised illnesses, such as mental disorders, herpes, depression, or urinary incontinence, were found to frequently access health services online to avoid uncomfortable or embarrassing discussions about their health (Powell and Clarke. 2006; Berger, et al., 2005). Within South Africa, where the maternal mortality rate has doubled in the last 15 years. SMS based health consulting plays an important role in delivering lifesaving information to expectant mothers. This service is particularly important for many pregnant women who are HIV positive, since according to the Mobile Alliance for Maternal Action (2013), 40% of maternal deaths are relate d to HIV/AIDS, and the stigma associated with the illness prevents mothers from seeking health related information through conventional means (Lach Dean, et al., 2012).

2.3.0 ICT for Development

Like the fashion business, the Third World development debate seems to go through fads and styles. Mantras come, and mantras go. The latest buzzword is knowledge. The world is now a Knowledge Society, we are told, and the global gap between know and know-not is growing, therefore the only way to give the poor the chance to catch up is to pump in more knowledge with computers and through the Internet.

-Kunda Dixit, 1999

The promotion of mobile phone enabled e-governance, such as the fault reporting system set up by the City of Cape Town, exists as a continuation of movements promoting the use of ICTs in development endeavors. Whenever new technologies appear, claims are often made about their potential to revolutionise development in the Global South. Starting in the 1990s, when the Network Society began to emerge, development agendas increasingly focused on improving ICT penetration in the Global South (Heeks, 2008). During this period there was a general belief that access to the Internet and personal computers would allow the poor to access information and services that could be leveraged for self-help, leading to 'telecentres' being built in poor communities around the world. These telecentres were intended to serve as locations where poor people could enjoy access to technology, and the presumed benefits it would deliver, thus closing the digital divide and reducing poverty. The assumption was that if given access to ICT, people would naturally leverage these tools to expand their knowledge, enter the global marketplace, and ultimately rescue themselves from the cycle of poverty. However, it is now commonly acknowledged that telecentres failed to live up to the expectations that were imposed on them (Heeks, 2008). Research focused on government sponsored telecentres in South Africa, states that of 65 telecentres developed between 1997 and early 2001, only 47% were fully operational by March of 2001, and of the original 65, a total of 21 were no longer functioning. Much of the failure was due to socio-cultural, technical and financial factors that made the telecentres a poor fit for addressing the needs of the communities where they were built (Benjamin, 2001).

Much like the telecentre trend in the 90s, in the past few years there has been a push to leverage mobile technology for development and governance purposes in the Global South. Research indicates that mobile phones have been the most rapidly adopted technology in recorded history; by 2010 there were an estimated 5.3 billion mobile phone subscribers worldwide, with ninety percent of the global population, including eighty percent of the world's rural population, living in areas served by mobile networks (OECD & ITU, 2011). It has been claimed that mobile technology significantly improves governments' ability to produce benefits and deliver services, especially in developing countries, by bypassing the infrastructural and geographical barriers, which limited the expansion of wired telephones and internet connections (OECD & ITU, 2011; Trimi & Sheng 2008). Mobile devices open new channels for citizen participation, and thus it has been suggested that they increase constituent participation in government (Trimi & Sheng 2008).

2.3.1 Amplification Theory

Despite the ubiquity of mobile phones and the proliferation of mobile based development projects, a growing number of researchers are expressing doubt that physical access to technology, in and of itself, has any meaningful impact on development.

Among the doubters is Toyama, who states,

> Theories of technology, or hypotheses that posit societal transformation through technology, might suggest that inequalities can be lessened by simply providing the technology to have-nots, or that the social problems such as poverty and political marginalisation can be mitigated primarily by a dissemination of technology. These mistaken beliefs lead to calls for universal access as a way to address inequality (Toyama 2011).

He goes on to further criticise the belief that technology facilitates development by stating that, "to expect the Internet to provide education where education is lacking is not unlike expecting a student driver to drive herself to driving

lessons." Toyama (2011) claims that instead of disrupting the social forces that cause poverty and inequality, technology merely acts to amplify whatever intents and capacities are already present in a population. Since the wealthy and powerful enjoy better access to ICT, and likely have the skills needed to employ them in complex and empowering tasks, they will undoubtedly be better positioned to engage with mobile development and governance projects, ensuring social inequalities remain intact.

Similar sentiments are expressed by Katz, who states,

> "the rich are going to be getting richer in terms of information, [and] the information poor will become more impoverished because government bodies, community organisations, and corporations are displacing resources from their ordinary channels of communication onto the Internet [...] to the extent that any demographic group who becomes excluded from and under-represented on the Internet, will also be excluded from the economic fruits that such participation promises" (Katz; quted in Goslee & Conte, 1998).

Amplification theory supports conclusions drawn by Tichenor, et al. (1970) who analysed the impact of mass media on social inequality. They concluded that the introduction of mass media information into a social system results in those with higher socioeconomic status acquiring this information at a faster rate than those of lower status, which results in an increased rather than decreased gap between haves and have-nots. Keeping in line with Amplification theory, Bélanger (2009) states that the result of e-governance is that the relatively well-off, who are more able to access and effectively use technology, enjoy increased convenience and responsiveness from government, while those who struggle to access and use ICT are disenfranchised.

It is clear that an ignorance of how ICTs fit into society have led to unsustainable projects, but what is more concerning is evidence which suggests e-governance amplifies inequality by excluding those without access to technology from

accessing government services. In order to avoid exacerbating South Africa's social fractures, it is necessary to consider that the adoption of e-government platforms could potentially inflame the problems they are supposed to relieve, if those underserved by public services lack access to the technology or the skills needed to communicate with government.

2.3.2 Autonomous Remote Sensor Networks

Effective integration of fault reporting into water and sanitation management is essential for timely and efficient repairs to infrastructure, which would be impossible without information on the performance of delivery systems. As has been stated, the City of Cape Town relies on user generated fault reports to receive this information. However, researchers have expressed doubt over the ability of user generated fault reporting to generate the information needed to adequately maintain water delivery infrastructure.

According to Thomson, et al. (2012)

> If no information is available, scheduled maintenance is possible but timely response to breakdowns is not. If repairs are only undertaken when faults are reported by users or village water committees, the system has a chance of working, but only in the case of a well-organised water committee and a motivated contractor.

Thomson's claims are supported by research funded by Making All Voices Count (2015) which analysed eight initiatives aimed at improving water service delivery through the use of ICT. Based on the analysis of the eight programs, it appears that ICT projects are more likely to fail when they depend on user generated reports to gain information on the state of infrastructure.

Autonomous remote sensing technologies are increasingly being used to monitor water delivery systems, which has the benefit of reducing service providers' dependence on user generated fault reports. Theoretically, this should improve

the maintenance of infrastructure, however, the practice of using remote sensors to detect system failures is still in its infancy and is largely untested. Like any other ICT, remote sensor networks must conform to the constraints of the local environment to be successful. Limited support infrastructure, and high costs have so far stifled the development of remote sensor networks in Sub-Saharan Africa (Cooper, et al. 2014). However, one initiative based on remote monitoring of hand pumps in Kenya has been shown to effectively improve information flow to service providers, resulting in a tenfold reduction in water pump downtime since installing automatic sensors (Making All Voices Count, 2015). In this system, the monitoring of hand-pumps is carried out by devices that sense how often hand-pumps are used by measuring lever movements. An SMS is sent to service providers if lever movement falls below a normal range, as this indicates the pump is not being used. This allows service providers to investigate why the pump is not being used and make repairs if necessary (Thomson, 2012).

Remote sensors networks are not only being used in hand-pumps, they are also being used to monitor water flowing through municipal pipes to detect anomalies in flow and contaminants. Within these systems remote sensors are used to detect contaminants and pressure changes (Gewin, 2015). Though this system has currently been applied in just a few Northern cities, there are plans to integrate them into the water delivery system in Johannesburg mayor (Slavin, 2015). The application of remote sensors in Johannesburg will provide an important opportunity to observe what impact, if any, remote sensor networks can have on fighting inequality in a South African context.

2.4.0 Socio-Cultural Determinants to Water and Sanitation Access

Those areas which lack water and sanitation mirror apartheid spatial geography. Former homelands, townships, and informal settlements are the areas in which communities and schools, who are black and poor, predominantly do not enjoy these rights and many others."

-South African Human Rights Commission, 2014

The literature presented in this section focuses on socio-cultural traits, which have been found to shape access to water and sanitation services. Social divisions within communities often hamper attempts at universal access to water and sanitation (Balasubramaniam, et al. 2014; Singh, et al. 2005), and much like what has been discussed regarding access to ICT, socio-cultural traits affect a person's access to water and sanitation in myriad ways (Singh, et al. 2005).

Just as unequally dispersed infrastructure leads to geographically based digital divides, unequally distributed water and sanitation infrastructure causes differential access to water and sanitation services. Geographic disparities in water delivery infrastructure is cited as a major factor leading to arsenic poisoning in rural Bangladesh. Ahmad, et al. (2007) found that rural Bangladeshis were frequently drinking water known to be contaminated, simply because safe water sources were located too far from their homes. Geographic barriers to water were also identified by Singh, et al. (2005), who reported on the Accelerated Rural Water Supply Programme, which is the oldest and largest government water supply initiative in India. Handpumps and piped water systems have been widely installed under the program, which has the mission of reaching marginalised castes and tribes. To achieve this aim, the government targets areas that are home to large populations of scheduled castes and tribes for upgraded water systems. However, it has been observed that a combination of geography and stigmatisation prevents members of scheduled castes from using handpumps in public spaces, which are dominated by high-caste groups, since local customs prohibit scheduled castes from using the same facilities as higher castes.

According to the UN Special Rapporteur on the right to safe drinking water and sanitation, Catarina de Albuquerque (2012), Stigmatisation plays a role in perpetuating, justifying, and creating impunity for violations which exclude

Ethiopia (2004) reports that stigma surrounding people who are HIV positive often prevents them from accessing water and sanitation services. Because community members perceive HIV positive individuals as a threat to public health, they are sometimes barred from using public toilets and water taps. Similarly, members of scheduled castes in India are frequently stigmatised and presumed to be dirty and 'impure'. It is commonly believed that their impurity is contagious through contact with individuals or objects handled by members of a scheduled caste (Deepa & Fawcett, 2006). Because safe water sources are often regarded as holy sites of worship in India, scheduled caste members are often prevented from accessing these sources for fear that their 'impurity' will threaten the site's sanctity (Deepa & Fawcett, 2006; Peacock, 2007). The belief that scheduled caste members will pollute water sources even prevents them from collecting water from public, non-sacred, taps. Peacock (2007) reports that in several Indian states it is an entrenched practice for scheduled caste members to be barred from clean drinking water sources. Furthermore, since scheduled caste members are traditionally employed in unsanitary tasks, such as the removal of human waste from latrines, the unavailability of water for washing also puts this population at great risk for contracting diseases associated with poor hygiene (Narula, 1999).

Even where the infrastructure exists to deliver safe water, the poor are often prevented from using it due to their inability to pay for it (Regmi & Fawcett, 1999; Smith & Hanson, 2003; Schouten & Moriarty, 2003). The relationship between income and access to water is strikingly similar to the relationship between income and access to ICT. In both cases the wealthy are better positioned to take advantage of the improvements offered by upgraded infrastructure in both areas. Just as the poor may not be able to invest in technology, even if they live in a well-connected region, they also may not be able to pay for clean drinking water, even where it is available.

In addition to poverty, spatial inequality, and stigma - gender has also been found to shape access to water and sanitation. In many traditional societies it is primarily women and girls who collect water and manage water resources, and

the accessibility of water facilities has a direct impact on the amount of time and effort they must spend on collection (Regmi & Fawcett, 1999). Unfortunately, women are seldom involved in the planning process when it comes to designing water and sanitation infrastructure, despite often having a greater qualitative knowledge of water resources than men; the effect of this, as Regmie and Fawcett (1999) observed in Nepal, is that women may not take an interest in protecting or maintaining water systems whose design or location were incompatible with their desires and needs. They reported that the Nepali women, whom they interviewed, complained that the time required to collect water significantly increased by 400-500% after their communities received 'improved' water services.

The ambivalence of women toward maintaining infrastructure could have significant consequences for municipalities that depend on user generated fault reports for the upkeep of its delivery systems. Interestingly, the gender based inequalities in water access observed by Regmie and Fawcett (1999) are based on women not being engaged in the development and design of infrastructure. This mirrors Best and Maier's (2007) statement that gender based digital divides stem from women not being involved in the development and design of ICT. In addition to gender, the literature review reveals that many of the sociocultural traits associated with limited access to water and sanitation services are also associated with barriers to participation in the Network Society. This suggests that e-governance may disenfranchise certain marginalised populations, thus perpetuating socially and historically entrenched inequality. It is necessary to examine the sociocultural barriers to engaging the City of Cape Town through e-governance platforms, particularly those used in the management of water and sanitation resources, considering the role essential services played in apartheid era population controls, and the current unrest stemming from the continued failure to properly deliver these services to the city's black African townships.

3.0 Water and Sanitation Delivery in Cape Town

Khayelitsha's dirty toilets and Cape Town's "poo wars" have become almost as famous as the mountain that overlooks the touristy city. But even though every human has a right to sanitation and dignity, shack-dwellers still relieve themselves on the side of the N2 highway. Khayelitsha's toilets tell a very different story to the travel brochures.

-Raeesa Pather, 2014

During South Africa's apartheid era, Cape Town's white population benefited from per capita water and sanitation investments on par with most European and North American countries. Most of this investment was highly subsidised, allowing white Capetonians to enjoy world-class municipal services, for which they paid very low tariffs (Smith & Hanson, 2003). The Coloured population also had relatively high quality municipal services, which were funded by taxes collected from Coloured business and commercial districts (Smith & Hanson, 2003). The black African population received municipal services through Black Local Authorities, which were ill-equipped to govern and operated with funds from national and provincial service levies. Overcrowding, poor governance, and inadequate funding resulted in deteriorated and scant water and sanitation facilities in black African townships (Smith & Hanson, 2003; Turok, 2001), which were inherited by the City of Cape Town when the three-tiered system of service delivery disappeared with the apartheid system of governance. This lead to enormous service backlogs in black African areas (Smith & Hanson, 2003), and since 1994 efforts have been made to integrate the city and improve infrastructure in poor areas. However, the municipality has been enormously challenged to provide services to historically underserved areas, and extreme inequality continues to characterise water and sanitation delivery.

The City of Cape Town (2001) defines basic sanitation as:

> The provision of a shared toilet (at a ratio of not more than 5 families per toilet) which is safe, reliable, environmentally sound, easy to keep clean,

> provides privacy and protection against the weather, is well ventilated, keeps smells to a minimum and prevents the entry and exit of flies and other disease-carrying pests.

Likewise, basic access to water is defined as:

> A minimum quantity of potable water of 25 litres per person per day: at a minimum flow rate of not less than 10 litres per minute; within 200 metres of a household; and with an effectiveness of not more than 7 days interruption supply to any consumer per year (City of Cape Town, 2001)

It has been reported that more than one third of people living in the city's informal settlements do not have access to any form of sanitation, and up to 70% of households lack access to a basic standard as defined by the municipality (Goldberg, 2009). Research indicates that over 100,000 Cape Town households depend on community stands to get water, of whom 58,000 were found to be using stands more than 200 meters from their homes. A further 22,000 households in Cape Town are reported to be using boreholes, spring water, rainwater tanks, dams, rivers, streams, or other insecure water sources (Makoni, 2011).

Besides struggling to meet the basic water and sanitation needs of poor Capetonians, the municipality also struggles to maintain existing water and sanitation infrastructure in black African townships. Public toilets and standpipes are supposed to be cleaned and maintained daily according to policies laid out by the municipal government (SJC, 2014). However, a social audit by the Social Justice Coalition (2014) found that in Cape Town's largest township, Khayalitsha, only 188 out of 528 inspected permanent toilets were acceptably hygienic. One third of surveyed residents reported that janitors were not cleaning toilets daily, and almost 60% stated that janitors were not working weekends, despite being required to do so. It was found that over one quarter of the inspected toilets were not in working order.

In addition to maintaining permanent toilets, the city contracts private companies to service portable toilets which are frequently used to relieve the demand for sanitation services, yet are not considered to fulfil the requirements of basic sanitation. A 2013 audit of portable toilets found that people living in areas of Khayalitsha served by portable toilets were having to share a single toilet with up to 26 families. No toilets in these areas were cleaned daily, and though they were supposed to be removed of waste three times a week only 68% had been serviced in the past seven days. It was found that over half of the toilets were unusable and another 66% were damaged (SJC, 2013).

Figure 1. Portable toilets in Imizamo Yethu. The city has provided portable toilets to alleviate the demand for sanitation infrastructure. However, it was reported that they are not used because they do not get emptied on a regular basis

Having information about the water and sanitation system is integral to overcoming maintenance challenges, and the City of Cape Town has adopted a number of methods to electronically gather information from user generated fault reports. The city adopted its SMS platform in 2008, based on the knowledge that most Capetonians own a mobile phone and therefore have the hardware necessary to send a fault report (City of Cape Town, 2009). Furthermore, sending an SMS is cheaper than contacting the call centre, which is reached using a 'shared access' number. Shared access means that when calling from a landline the caller is billed at a reduced rate. However, Eighty-three percent of black Africans in Cape Town depend on mobile phones as their sole means of communication (City of Cape Town, 2014), thus preventing them from contacting the call centre at the discounted price.

While minor repairs to standpipes and toilets are the responsibility of janitors, the City is responsible for fixing major breakdowns. The City depends on janitors and the public to report faults so that they can be aware of what repairs need to be made (SJC, 2014). However, it was found that despite the reporting systems established by the City, a very large percentage of toilets are either not usable or damaged (SJC, 2013; SJC, 2014). While there is a clear need for maintenance, the City claims to log few fault reports from informal settlements (SJC, 2014). A particular problem is that the City's fault reporting system is not designed to address the needs and abilities of the City's poorest residents.

According to the Social Justice Coalition (2014),

> Most residents in informal settlements use mobile phones and it is a premium rate telephone number to call the City. A ten minute conversation costs up to R25.00, depending on the network. Currently, the City provides only three landlines for the whole of Khayelitsha to report faults for free. If residents want to report a fault, then they need to walk or take a taxi to one of these phones. Alternatively, if residents wish to use the SMS facility, there is no guidance on what information to send. […] Regardless, it is impossible to report faults for specific toilets in informal settlements through the call centre as it does not have the

facility to locate and direct maintenance teams where there are no house numbers and roads.

It appears that the failure of official communication channels encourages residents of informal settlements to turn to protest actions to inform government officials about their water and sanitation needs (Allan & Heese, 2011).

3.1.0 Service Delivery Protests

Service delivery protests have become an entrenched part of South Africa's political process. According to Nhleko (2015), the South African Police Service (SAPS) committed resources to 14,740 protest incidents, 2,289 of which turned violent, during the 2014/15 fiscal year alone. Protesters often take their grievances to the streets, because they lack adequate communication channels with municipal officials, and feel they have exhausted all other avenues for getting improved services (Grant, 2014; Allan & Heese, 2011). The Western Cape, which was the most protest effected province in 2012, has since fallen behind Gauteng, the Eastern Cape, and Kwa-Zulu Natal (Municipal IQ, 2012; Municipal IQ, 2014). However, the Western Cape's falling in the rankings is likely due to protests becoming more prevalent nationwide, and not because their frequency has decreased in in the province. As a whole, South Africa has seen a 96% increase in the number of protests since 2010 (IRR, 2015). Service delivery protests present a major threat to the socio-economic stability of the province and the City of Cape Town. For instance, a solitary protest action in May 2015 cost The City of Cape Town ZAR 18 million to cover overtimes expenses and repair damages caused by protesters (Kekana, 2015). This figure does not take into account the costs associated with road closures, property damage, injuries or fatalities (Phaliso, 2015; Kekana, 2015). The true costs of service delivery protests is far reaching and ripples through the economy; the scope of economic losses associated with protest actions falls beyond the focus of this study, but it is safe to assume they are highly significant to the economic stability of South Africa.

4.0 Research Design & Methodology

This study looks at specific socio-cultural traits, and examines what affect they have in determining a person's level of access to water and sanitation services, and their use of mobile technologies. The aim is to understand if subsets of the population who are marginalised in terms of access to services have the technological capacity to advocate for improvements using the mobile phone enabled fault reporting systems set up by the City of Cape Town. Analysing data on the socio-cultural makeup of a community, and how various subsets of the population use ICT, and water and sanitation services, can build an understanding of who engages in fault reporting, and perhaps more importantly, whether there is a relationship between reporting and the quality of services that are delivered.

4.1.0 Study Site Selection

In order to gain a better understanding of the social and cultural factors that contribute to dissatisfaction with water and sanitation services in Cape Town's black African townships, it was important that the study site be representative of these areas in terms of demographics and services delivered. Therefore, the study site needed to have a high percentage of people living without in-home access to water and sanitation services, and have a predominantly black African population. Census data from the City of Cape Town, which shows the racial makeup and percentage of households without in-home access to water was analysed, allowing for the elimination of several census tracts based on their incompatibility with the selection criteria. Imizamo Yethu, where 62% of the population lives without in-home water access (City of Cape Town, 2013) was ultimately chosen over other sites due to its relatively small and densely settled population, which made it possible to sample the whole area in a short amount of time. Other factors which contributed to the selection of Imizamo Yethu was its ease of access, and the willingness of the local ward counselor to help organise field studies.

4.2.0 Cross Sectional Study

The study was organised as a cross sectional study, which is an observational and descriptive form of analysis that allows for the observation of a community issue at a specific point in time. Cross-sectional studies are commonly employed to estimate the prevalence of a specific outcome within a population; this method is often used for analyzing socio-cultural factors in relation to outcomes. Chi-square tests, which detect statistically relevant relationships between two variables were employed as part of the cross-sectional study. Chi-square tests allow researchers to identify relationships between two categorical variables, which can quantifiably highlight differences in the lived experiences between members of various groups in relation to one another.

4.3.0 Deciding What Socio-Cultural Variables to Analyse

To determine what variables to analyse, examples were found in existing literature focusing on socio-cultural barriers to the adoption of ICT, and access to water and sanitation services. These variables include**:**

- **geography** (Graham 2001; Thapa & Saebo 2007),
- **gender** (Geldof 2011; Huyer & Mitter 2003; Olatokun 2007, Dodson, et al. 2013),
- **education** (Geldof 2011; Bartolome 2014; Tembo, et al., 2010),
- **age and physical ability** (Neves, et al. 2013; Heart & Kalderon, 2013; Tembo, et al., 2010; Xie 2003),
- **stigmatisation** (de Albuquerque, 2011; WaterAid Ethiopia, 2004; Johns, n.d.)
- **and income** (Chen & Wellman, 2004; Chinn & Fairlie, 2006; Graham, 2001; Van Dijk, 2006, Neves & Amaro 2013).

Observations made during site visits as well as discussions with community members also influenced the decision to include certain variables in the analysis. While visiting the township it became apparent that Imizamo Yethu has many foreign born residents. Even though no literature was found that linked citizenship to service delivery or access to ICT, it was decided to ask respondents to identify their place of birth to determine if there are differences in access between foreign born residents and native South Africans. Several people in the township also mentioned their struggles with chronic illnesses such as HIV and Tuberculosis, so it was decided to look for correlations related to health as well. Another observed characteristic of the community was that many residents had just recently moved to the township, primarily from the Eastern Cape to join family in Imizamo Yethu. Since so many people were new to the area, and many of these new arrivals had come to join family members, it was decided to see if access to services and technology is related to a respondent's length of residency in the township, as well as the amount of family members they provide for.

4.3.1 Accounting for stigmatisation

Because of the literature linking stigma to water and sanitation access and the use of ICT, it was seen as an important variable to consider. However, it has to be recognised that it may be difficult for researchers from outside the community to recognise which groups have a stigma imposed on them. Also, it may be difficult to discuss issues of stigmatisation in face-to-face interviews, because the issue stems from people's negative experiences and perception of others in the community; making stigma an inherently sensitive topic of discussion. Discussion of sensitive topics is often inhibited by people's fear of shame, judgment, or retribution for expressing an opinion that runs contrary to the dominant community narrative, or contrary to the perceived beliefs of the interviewer. (Tourangeau & Yan 2002, Gregson, et al., 2002).

The technique used allowed for the rapid identification of stigmatised groups. Given the limited time frame and resources, open ended questions were asked

based on factors identified by Blank, et al. (2004), which lead to the development of prejudicial beliefs. This seemed appropriate since stigma and prejudice are closely related in the sense that they both result from negative perceptions being applied to a group based characteristics shared by group members. According to Blank, et al. (2004), prejudice stems from the perception that one group's presence endangers the values, economic opportunities, or physical safety of another group. Research into the body's physiological response to interaction with stigmatised individuals, shows that people exhibit characteristics equivalent to experiencing a threatening situation when forced to interact with someone they hold a stigma against (Blascovich, et al., 2001). This lends credibility to the decision to use questions based on the threat factors associated with prejudicial beliefs to identify stigmatised groups.

Stigmatised subsets of the population were identified through a discourse analysis of the gathered responses to open ended questions. Since data had already been collected on some of these groups, it was possible to test for similarities in their access to water, sanitation and ICT, which would indicate any overarching role that having a stigma imposed on them plays in shaping access. It must be noted that these groups may experience the imposition of stigma in different ways, which could potentially impact their access to services and technology. However, examining how groups experience stigma, and the role this plays in shaping access, falls beyond the scope of this study.

4.3.2 Selection of other variables

The decision on what water and sanitation variables to analyse was based on discussions with community members, community leadership, and representatives of locally active NGOs. Variables pertaining to mobile technology were chosen through informal discussions about commonly used mobile applications in South Africa, as well as on the skills and hardware an individual would need to participate in mobile phone based fault reporting. A complete list of considered variables can be found in Table 1.

Table 1. Analysed variables

Variables		
Socio-Cultural	**Water & Sanitation**	**ICT**
Age	Water in home	Mobile phone ownership
Gender	Toilet in home	Calling
Health	Distance to water	SMS use
Disability	Distance to toilet	Overall technological capacity (number of mobile apps and features)
Stigmatisation	Satisfaction with water quality	Mobile phone use in the past week
Geography	Satisfaction with public toilets	
Citizenship	Frequency of water service disruptions	
Income	Time spent waiting to use facilities	
Education	Frequency of toilet cleaning	
Citizenship		
Number of dependent		

4.4.0 Survey Design

The survey questionnaire used in the study was divided into four sections. The first section gathered data on respondents' socio-cultural characteristics by asking questions related to a person's gender, age, health, physical ability, place of birth, and economic ability. The second section was designed to help identify stigmatised groups within the study site. This was done by asking respondents to identify types of people they felt were a threat to the community. The third section collected data on respondents' experiences accessing water and sanitation services, and the final section asked questions regarding their mobile phone use.

Since surveys were carried out as face-to-face interviews, but dealt with some potentially uncomfortable topics, it was decided to use a combination of direct questioning and a method developed by Gregson, et al. (2002) Informal

Confidential Voting Interviews (ICVI). Direct questioning was used for the questions asked in the first, third and last sections of the survey, but in an attempt to encourage a frank discussion of people's feelings about others in the community, questions from the second section were asked using ICVI to maximise privacy. ICVI is a survey technique that has been shown to encourage truthful responses to sensitive questions in certain developing country contexts (Gregson, et al. 2002), and was therefore incorporated into the questionnaire design. The technique blends aspects of face-to-face interviews with self-administered survey methods, by allowing participants to answer sensitive questions anonymously and privately by writing answers on slips of paper which are placed into a sealed ballot. This confidentiality measure is meant to assure respondents that answers are kept private. This technique has not gained widespread use, but was successfully implemented in a Zimbabwean HIV study to gain information on sexual practices. Unfortunately, the method is not without limitations, the biggest being its inability to engage non-literate populations (Gregson, et al., 2002). While conducting surveys, low-literate respondents would sometimes need help writing responses to ICVI questions, which may have influenced what sentiments or beliefs they were willing to express.

4.4.1 Calculating Sample Size & Survey Interval

A sample size calculator by Raosoft, Inc. (Raosoft, 2004) was used to determine the ideal sample size for this study. The goal was to have a sample size that would allow for no more than a 5% margin of error, at a 95% confidence level, with a 50% response distribution. Based on the City of Cape Town's estimate of Imizamo Yethu's population size of around 15,000 (City of Cape Town, 2013) and Rosenberg's estimate of 60,000 (Rosenberg, 2013), it was determined that a sample size of 375-385 respondents would be ideal.

Since respondents were surveyed at their homes, it was important to ensure that an interval was chosen that would evenly spread out participants as much as possible. According to census data, there are around 6000 households in

Imizamo Yethu (City of Cape Town, 2013). That number was divided by the target sample size, 380, which came out to 15.78. Based on this figure, it was decided to count 15 houses between those where interviews were conducted. This ensured a distribution that was spread as evenly as possible throughout the study site.

4.4.2 Data Collection

One hundred sixty-eight interviews were conducted in the township over three days in May 2014 by the author and two research assistants. The research assistants were student volunteers from the University of Cape Town. The author and both research assistants were each accompanied by a local Xhosa speaker to act as a guide and interpreter. These guides were recruited by Imizamo Yethu's Ward Councilor. All research assistants and guides received instruction on how to carry out ICVI, and were instructed on the protocols of conducting interviews, including how to receive informed consent. Weather and social unrest caused the survey period to be cut short, which resulted in a survey size smaller than what was desired. Interviews were conducted with the help of translators who could speak the dominant language, Xhosa, and a survey interval of fifteen houses was adhered to as strictly as possible. In cases where there was no one home, or no one wanted to be interviewed, someone from a neighbouring home would be surveyed and the interval would continue from there. Due to the informal and erratic layout of the township, it was not always possible to walk down a defined street and count houses. However, an effort was always made to count 15 houses between those that were surveyed.

Environmental hazards, such as aggressive dogs, prevented access to certain parts of the study area, but despite the challenges, the distribution of respondents was evenly spread throughout the study site. The approximate location of each surveyed individual's home was marked on an aerial photograph with a number corresponding to their completed survey. This was done so that geographical coordinates could be assigned to data for use in spatial analyses.

4.5.0 Methods of Analysis

4.5.1 Chi-Square

A chi-Square statistical analysis was used in this study to identify correlations between socio-cultural traits and ICT habits, as well as socio-cultural traits and access to water and sanitation services (SPSS 21.0; IBM, 2012). Chi-Square is a test for independence used to identify relationships between two categorical variables. Expected frequencies are compared and observed frequencies of a particular population in a contingency table sized two cells by two cells, or larger. In a chi-square analysis the expected frequency is the number of responses that should be expected if no correlation exists; the absence of correlation is known as the null hypothesis. In this type of analysis, the observed frequency is the actual number of responses given. The differences between the observed and expected frequencies are combined to form a chi-square statistic and a corresponding p-value. The test is carried out as a one tail test, and if the observed frequencies vary significantly from the expected frequencies, which is evidenced by a p-value of less than 0.05, the null hypothesis can be rejected, indicating a relationship exists between the variables (Cutting, 2002).

A limitation to Chi-Square is that its accuracy depends on at least 80% of the cells within a contingency table having a value greater than five. This is particularly problematic when looking for relationships among small samples, as there will generally be many tables that do not meet this threshold. To overcome this limitation, IBM SPSS statistical analysis software was used to run chi-square analyses using the Monte Carlo method, which gives an unbiased estimate of the exact p-value needed to reject the null hypothesis (Mehta & Patel, 1989). The p-value generated using the Monte Carlo method is more accurate than those obtained using a standard chi-square test, thus allowing for the comparison of variables even when fewer than 80% of cells have values greater than five.

Data on the number of mobile applications and features used by respondents was gathered by having them identify the features and applications they use from a list of twelve applications and five features. The number of used features and applications were aggregated to give an overall technological capacity score, which was the variable used in the chi-square analysis. All variables were put into an Excel spreadsheet, and if the variable was not already expressed as a numerical value, it was numerically coded, and then imported into IBM SPSS. Chi-square tests were then run using the numerically coded variables to identify statistically relevant correlations.

4.5.2 Discourses Analysis

Responses written on ICVI ballots were analysed using NVivo qualitative analysis software (Version 10; QSR International, 2012). Ballot responses were entered into NVivo and run through a discourse analysis to identify groups of people who are commonly cited as a threat by the surveyed population. This was done to gain an understanding of what groups are stigmatised within the survey site to understand how stigma, as a socio-cultural trait, may act as a barrier to accessing services or ICT. Respondents were encouraged to write responses in their first language if they were uncomfortable or unable to write in English. Translation of these ballots was attempted using online translation tools. If a clear translation could not be obtained, the ballot was rejected.

4.5.3 Spatial Analysis

In order to visualise geographic disparities in access to services and ICT, ArcGIS (Version 10.2; ESRI, 2013) was used to spatially analyse disruptions to water delivery service, and SMS use. While conducting surveys, the location of each respondent's house was marked on aerial photographs of the study site using a unique number that corresponded with a completed survey. This allowed for the assignment of GPS coordinates to the collected data.

After importing the survey data into ArcGIS, the survey points were represented

as discrete point features, which means that at any given location on the map, the feature is either present or not (Mitchell, 1999). For each category of a feature, a different colour was assigned for the variable. For instance, for the variable 'Distance to water' the location of respondents traveling over 20 minutes would be expressed as a red dot. To make it easier to identify spatial patterns, discrete points were converted to raster layers using the interpolation tool 'Natural Neighbour Spatial Analyst'. Natural Neighbour is used to predict what values would be present at a non-sampled location based on the values of the nearest sampled points.

Spatial Data containing the location of pressurised water mains and stand pipes were obtained from the University of Cape Town's GIS laboratory, and these features were laid over the raster layers to visualise the spatial patterns of variables in relation to these features. A layer containing the location of respondents who reported not using SMS was also laid over the raster layer representing disruptions to water service. This was done to identify geographic digital divides within the study site, and visualise where they correspond to water delivery disruptions. Additional maps representing the distribution of age, and people with disabilities were generated to compare these populations' settlement patterns with the distribution of SMS users and water delivery disruptions.

5.0 Study Site Description

Imizamo Yethu is a predominantly black African township located in the seaside suburb of Hout Bay, about 20 km south of the Cape Town CBD. About 75% of the population is aged 15-64, and about 25% are younger than 15. There are very few people aged 65 or older; this demographic makes up less than 1% of the township's population. Educational attainment is low, and poverty rates are high in Imizamo Yethu, only about 31% of the population has completed high school, and about one quarter of the population receives no monthly income, while another quarter earns less than ZAR 1600 a month. Over 75% of the population lives in informal housing, while over a quarter lack basic access to water, and nearly a third have no toilet access (City of Cape Town, 2013).

The settlement is tightly contained with an extremely high population density. Imizamo Yethu is surrounded on three sides by upper and upper-middle class neighbourhoods whose population is predominantly white, and on one side by Table Mountain National Park. The township was established in 1991 in response to an influx of black Africans moving into the area because employment opportunities were available in Hout Bay. Prior to the establishment of Imizamo Yethu, the black African population was settled in squatter camps along Hout Bay Beach on private property, which led to tension with the predominantly white residents of the area. It was decided that the squatters would be moved onto an 18 hectare plot of land that was previously held as forestry reserve (Lohnert, et al., 1998). A defining characteristic of Imizamo Yethu is its location on the steep flank of a mountain. The terrain becomes steeper, and housing more informal, as one travels up the slope.

5.1.0 History of Imizamo Yethu

Xhosa speaking people from the Eastern Cape form the bulk of the population, but there is a large and cosmopolitan minority made up of people from across the African continent and as far afield as China (Tokwe, 2014). Despite the diversity of the population, the township has a history of xenophobic violence.

One such incident took place in 1996 when an armed mob of around one thousand individuals, attempted to force all foreigners out of the township resulting in two immigrants being fatally wounded and dozens more injured (Dodson & Oelofse 2013).

Since its founding, Imizamo Yethu has experienced rapid population growth that has outpaced the construction of infrastructure and houses. Because of this, most residents live in informal housing. The site originally housed just 450 families, who were moved from squatter camps on private land (Visagie, 2008), but the population has since ballooned to a considerably larger size. Like most informal settlements, it is difficult to accurately gauge the number of people who call the area home. Estimates of Imizamo Yethu's population vary from around 15,000 (City of Cape Town, 2013) up to 60,000 (Rosenberg, 2013). Regardless of the actual population, overcrowding is a concern as it overburdens the limited infrastructure, leads to conflict over resources, and promotes unsanitary living conditions.

5.2.0 Observation made during site visits

During site visits, the smell of garbage often hung in the air. In the informal area at the top of the settlement, domestic refuse gets piled around water collection points, because no appropriate location exists for garbage disposal. Rain and water leaking from standpipes wash garbage and polluted water down into the settlement where it collects in stagnant, tepid pools. The availability of toilets is also a problem in the township. Due to overcrowding, public toilets were falling apart and some have become unsanitary to the point of no longer being usable. This has led to conflict in the community with some residents putting locks on public toilets, effectively converting them to personal property. Because many people lack access to public toilets, they practice open defecation in the open spaces above the township in Table Mountain National Park.

According to many of the people, substance abuse, particularly alcoholism, is a serious problem. One community member commented that intoxicated men sometimes get rowdy and destroy public standpipes; resulting in disruptions to water service. Many people also expressed worry over increasing incidents of

gang related crime, particularly among young people.

Working age adults make up a large portion of Imizamo Yethu's population. Demographic evidence suggests that people commonly migrate to the township from the Eastern Cape during their prime years, and return home when they are of retirement age (Figure 4). This type of movement is known as circular migration, and was institutionalised under apartheid through the use of influx controls. These restrictions were removed in the late 1980s and it was assumed that after they were lifted, black Africans would permanently settle near their places of employment, bringing with them their families, thus ending circular patterns of migration (Posel, 2004). However, demographic profiles of the Eastern Cape and Cape Town's black African suburbs provide evidence that circular migration still characterises settlement today. Though it cannot be proven from the collected data that this is attributed to the state of water and sanitation infrastructure, it seems likely that the harsh living conditions in Cape Town's townships would be a factor contributing to people's decisions to return to the Eastern Cape.

There is a pronounced deficit of working age adults (age 15-64) in the Eastern Cape, compared to Imizamo Yethu as can be seen in Figure 4 shows. In contrast, the elderly population of the Eastern Cape is much larger than that of Imizamo Yethu. People aged 65 or older make up only 0.6% of Imizamo Yethu's population, whereas they make up 6.7% of the population in the Eastern Cape (Statistics South Africa, 2011; City of Cape Town, 2013). The situation in Imizamo Yethu is repeated throughout the City of Cape Town. Of the municipality's predominately black African suburbs and townships, Summer Greens has the largest percentage of elderly residents, at 3.9%. This is still less than the elderly population of Kou-Kamma, the Eastern Cape municipality with the lowest percentage of residents aged sixty-five years or older, where the elderly make up 4.5% of the population. The elderly make up well over 8% in several Eastern Cape municipalities, with Ngqushwa, where they make up nearly 12% of the total population, taking the number one spot (Figure 5).

Figure 2. The wealth of Hout Bay's predominantly white neighbourhoods, which surround Imizamo Yethu on three sides, is clearly visible from the township's informal settlements.

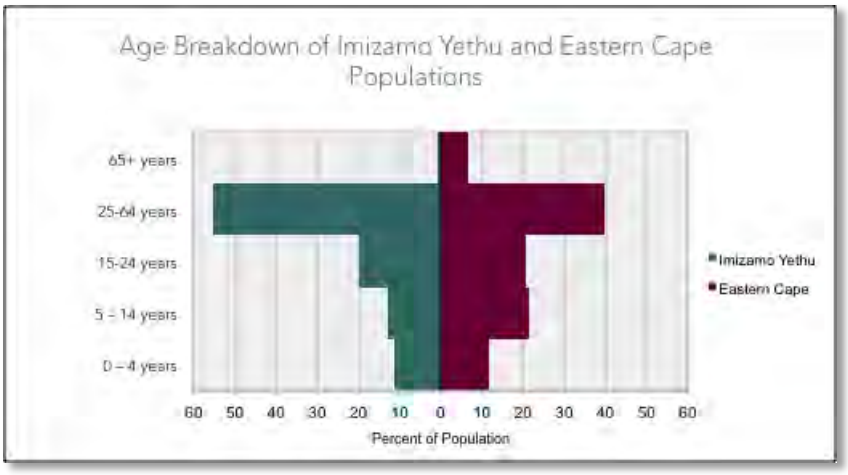


Figure 3. Age profile of Imizamo Yethu and the Eastern Cape.

Besides having a disproportionately large elderly population, the Eastern Cape also has a higher prevalence of disability than the Western Cape, whose percentage of people with disabilities is about 4% of the total population. In contrast, the Eastern Cape has a much higher rate of about 6% (Statistics South Africa, 2005; Maart, et al. 2007). The fact that South Africans with disabilities are concentrated in the poorest provinces suggest that these populations are not migrating at the same rate as others. A particular challenge those with mobility issues face in Imizamo Yethu is the mountainous terrain. The township is located on the steep flank of a mountain, so it may seem logical that people with mobility issues would avoid settling in Imizamo Yethu. However, none of Cape Town's black African townships, most of which are located on the plains east of the city, have large elderly populations; a fact which may suggest that the design and maintenance of infrastructure, and the availability of services, has at least as much of an impact on the ability of the elderly and disabled to settle in Imizamo Yethu as the natural environment.

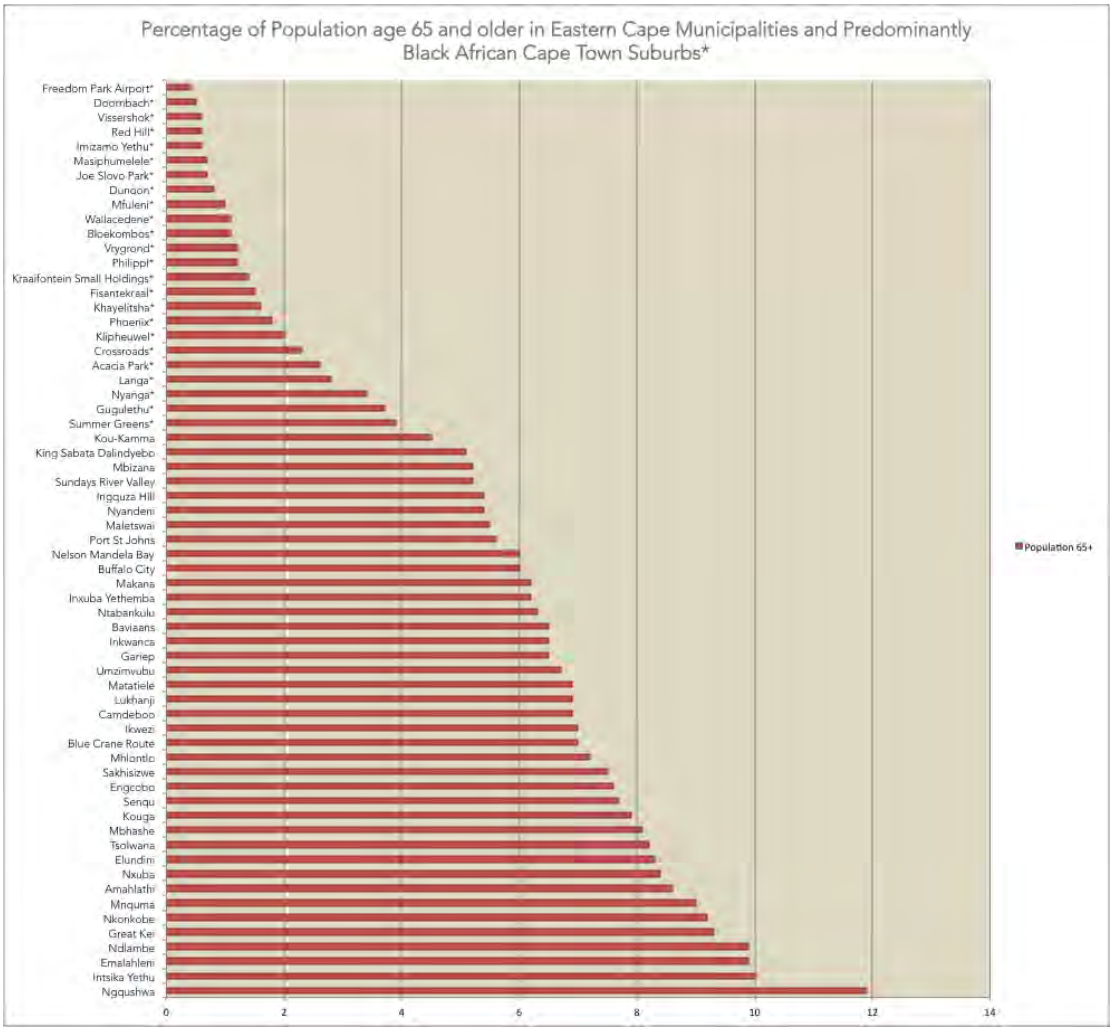


Figure 4. Percentage of elderly in Cape Town's black African townships and the Eastern Cape

6.0 Analysis of ICVI Data

The purpose of employing ICVI was to identify groups who are stigmatised in Imizamo Yethu, so that trends could be identified in the chi-square analysis of these groups, to understand if the imposition of stigma has an impact on access to water and sanitation, or the use of ICT. Because the root cause of stigma lies in people's negative opinions about other community members, it is inherently a sensitive topic to discuss. Ensuring privacy and anonymity has been shown to elicit honest discussion on socially sensitive topics, but unfortunately, privacy is often hard to come by in informal settlements. Therefore, ICVI was employed as a privacy measure to ensure responses were anonymous. For information on the limitations of ICVI to reduce social desirability bias in this study, see the sidebar on page 52.

The sentiments that were most often expressed through ICVI were a distrust of local leaders, a fear of criminals, a fear of people whose nationality differs from that of the respondent, a fear of young people, and a fear of men. The breakdown of how often these sentiments were expressed in relation to each other can be seen in Figure 5. While it was expected that people would be afraid of criminals, and based on the history of xenophobic violence in the township, it isn't surprising that a lot of people feel mistrust toward foreigners. However, it is interesting that so any people feel threatened by community leaders. This may negatively impact the City's ability to engage township residents since community leaders are expected to act as liaisons between citizens and the municipality.

Since data had been collected on gender, it was possible to test for differences in access and use between men and women. Data that had been collected on age allowed for the analysis of young people's access to water, sanitation, and ICT, and data collected on respondents' country of birth allowed for the analysis of differences based on citizenship. These three variables taken together allowed for the analysis of stigmatisation's impact on services in Imizamo Yethu.

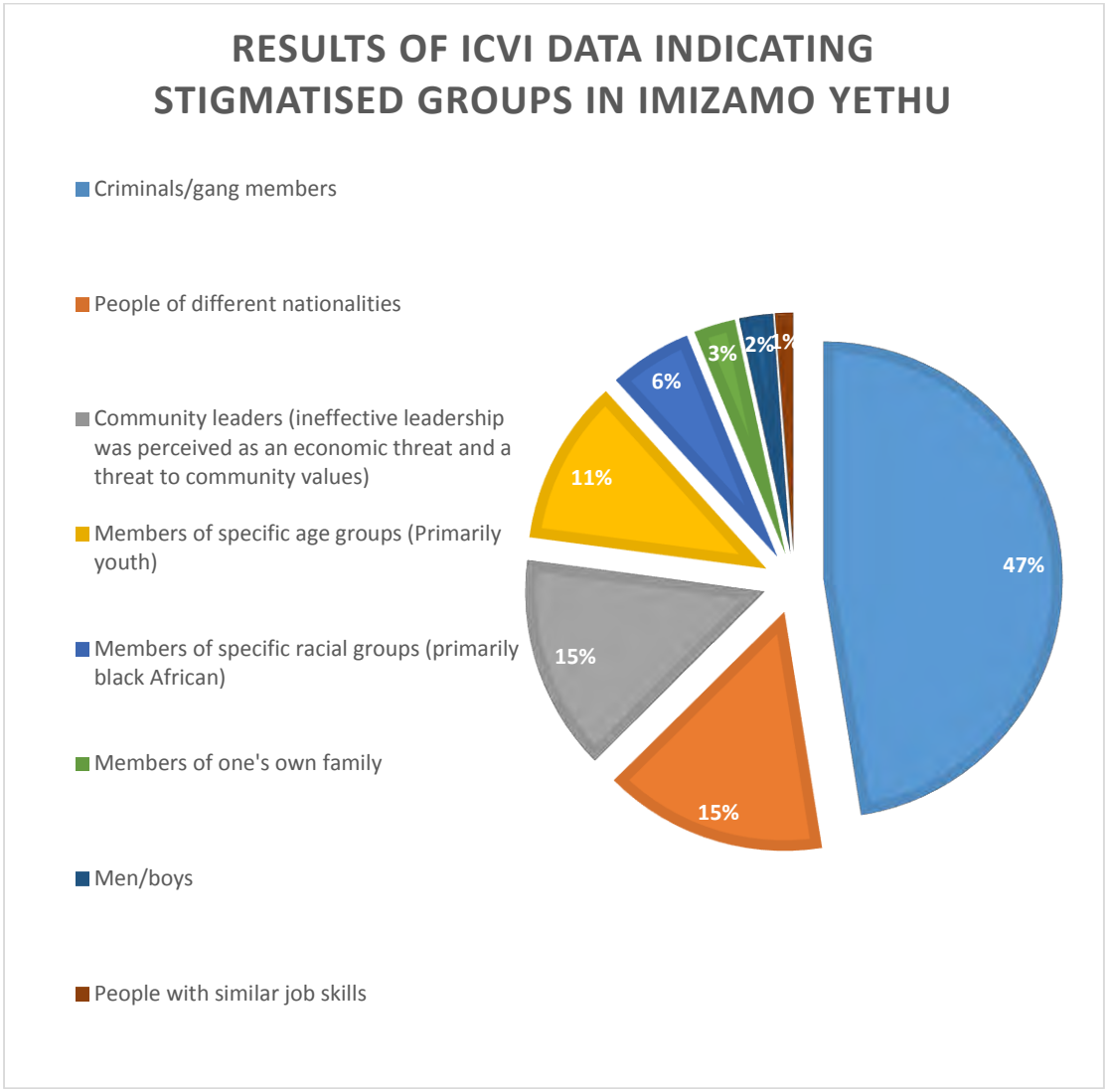


Figure 5. Stigmatised groups in Imizamo Yethu.

7.0 Statistical Analysis

The following statistical analysis identifies the relationships that various groups, defined by shared socio-cultural traits, have with access to water and sanitation services and mobile phone use. As has been stated, the objective of this analysis is to understand which segments of society, if any, are disadvantaged in their access to water and sanitation, and explore whether members of these groups have the capacity to report their problems and concerns to the City. For a complete list of the variables that were analysed, refer to Table 1 (page 27).

7.1.0 Age, Physical Ability, & Health

In order to assess the correlations between age, physical ability, health, and access to water and sanitation, the chi square analysis of these variables was carried out in IBM SPSS. Overall, only 41% of respondents in the age group of between 30 and 40 years reported having access to water in their home. The rate of in-home water access increases with age; 59% of those in their forties reported having water in the home, and 93% of respondents over 50 years of age reported having water in the home.

Limitations of ICVI's anonymity measures

There were some interesting observations made regarding the collection of ICVI data that are not explicitly related to access to water and sanitation services or ICT use. However, because ICVI is not widely used and there is currently a shortage of survey methods that offer privacy in informal settlements, it was decided to present these findings to inform the development and evolution of the technique.

Perhaps the most significant finding was that the presence of well-known community leaders discouraged people from participating in ICVI, and appeared to influence their willingness to express strong opinions despite the anonymity measures built into the technique. While it is unavoidable and expected that the biases and interpretations of translator will skew the data, the results of ICVI indicate that interviewees' biases toward the translator also skew their responses. This is generally expected when conducting face to face interviews, but ICVI is designed to reduce the impact of interviewee bias. However, it was observed that people still appeared to tailor their responses based on their perception of the translator.

On the first day of interviews, one researcher was accompanied by a local Ward Councilor, over the course of the day, seven out of the ten people interviewed refused to answer questions using ICVI. Most of them simply stated that there were no problems in the community. The Ward Councilor was not available to interpret on the second day of interviews, but he arranged for another well-known community figure to interpret. Of the seven interviews carried out on the second day, no one refused to participate in ICVI. However, despite people's willingness to answer questions using the technique, they did not express thoughtful views or opinions. Judging from responses, it seems likely that the interpreter was asking pointed questions rather than open ended queries. This is evidenced by the fact that most respondents simply answered 'no' to all three questions. This seems to indicate that they felt there were no groups whom they perceived as threatening in the community, which is very similar to the sentiments expressed by respondents when the Ward Councilor was acting as interpreter.

On the third and final day of interviewing, the same researcher was paired with another interpreter who did not work in the community and confided that she knew very few people in Imizamo Yethu. Of the nineteen people interviewed, no one refused to participate in ICVI, and respondents were much more expressive in their views and opinions than they had been the previous two days. Interestingly, four respondents reported that they felt that community leaders posed a threat to Imizamo Yethu, which was a sentiment commonly expressed in ICVI ballots collected by other interviewers not accompanied by well-known community members. Despite taking steps to ensure responses are confidential, it seems that the presence of influential people discourages the expression of strong opinions and views. Overall, complaints about community leadership were among the most common views expressed using ICVI. However, not a single participant expressed this view when community leaders, or those known to be related to community leaders, were present for interviews. It seems that people may not trust that ICVI provides full anonymity, or may worry that their participation in the process would arouse suspicion.

Respondents in their teens and twenties were found to have higher rates of in-home water access than respondents in their thirties, with about 77% of respondents under the age of twenty-five having water access at home. The age distribution of respondents with in-home access to water can be seen below in Figure 6.

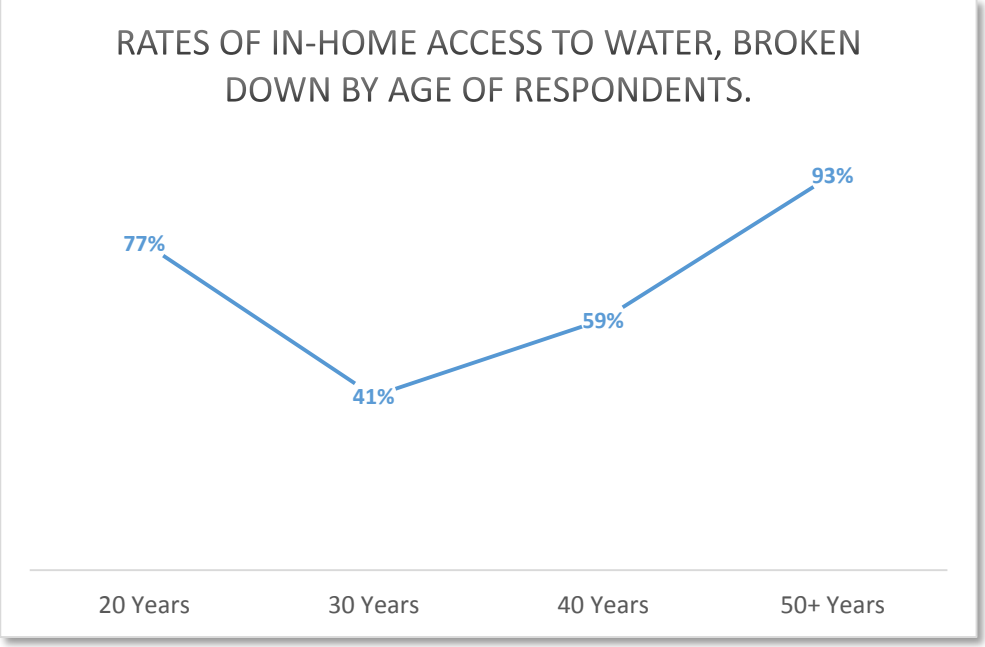


Figure 6. Differences in in-home access to water between different age groups in Imizamo Yethu.

Fewer people have a toilet than have water in their home. In total, 66% of the sampled population had in-home water access, whereas only 55% have in-home toilet access. However, the distribution of in-home toilets largely mirrors that of in-home water. As can be seen in Figure 7, those over fifty years old have the highest percentage of respondents, 87%, claiming to have a toilet in their home. Respondents in their thirties, once again, had the lowest percentage, just 35%, reporting to have a toilet in the home.

Variable A	Variable B	P-Value
Age	In-home access to water	0
Age	Travel time to access water	0.001
Age	Frequency of toilet cleaning	0
Age	In-home access to a toilet	0
Age	Travel time to access toilet	0.001
Age	Time spent waiting to use facilities	0.037
Age	SMS use	0.001
Age	Overall technological capacity	0.004

Table 2. Variables with statistically significant relationship to age with corresponding p-value.

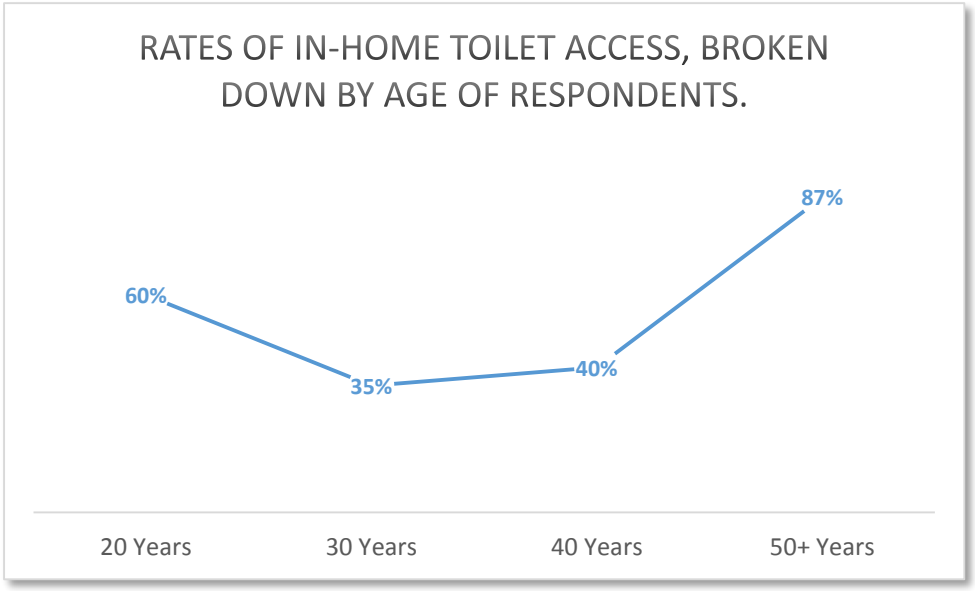


Figure 7. Differences in in-home access to toilets between different age groups in Imizamo Yethu.

The cleanliness of sanitation facilities also correlated with age. This appears to be related to in-home toilet access, since those with toilets in their home are likely to clean them on a regular basis. Though public toilets are supposed to be cleaned daily, the findings showed that they are cleaned much less frequently. Respondents in their thirties were found to be using the dirtiest toilets; 30% of respondents in this age group claim that their toilets are almost never cleaned, or cleaned only once every few months. This stands in contrast to those over 50 years; among this cohort, 93% claimed that their toilets are cleaned nearly every day.

Age was found to have more correlations with water, sanitation, and ICT variables than any other socio-cultural trait. As seen in Table 2, P-values between 0 and 0.037 indicated age relates to in-home access to water and toilets, time spent traveling to use facilities as well as the amount of time spent waiting to use them, as well as the hygiene of toilets used by respondents. It was observed that people in their thirties are the least likely cohort to have access to water and toilets in their home. As the age of respondents' increases, fewer and fewer use public facilities, which in turn results in less time spent traveling to access facilities, and less time waiting to use facilities, since older respondents are likely using private toilets.

The built environment of Imizamo Yethu, including the public water and sanitation facilities, was not designed around the needs of mobility challenged populations. Therefore, it was not surprising to discover that as people age, and presumably lose mobility, they use public facilities less often. Though the questionnaire did not establish why people lived in particular houses, or how they obtained them, it was observed that elderly people are usually found in settings where they have access to private facilities. It appears that this is not due to any inherent privilege, but may simply be because those are the only facilities in the township that support their needs and abilities. A similar trend was identified among people with disabilities. Respondents living with a disability also tended to be found living in locations that provided in-home access to toilets. The table below (Table 3.) shows the variables that correlated with physical ability and the p-values that express those correlations.

Table 3. Variables with statistically significant relationship to disability with corresponding p-value

Variable A	Variable B	P-Value
Disability	In-home access to a toilet	0.008
Disability	Travel time to access a toilet	0.02
Disability	Frequency of toilet cleaning	0.021
Disability	Mobile phone ownership	0.015
Disability	SMS use	0
Disability	Overall technological capacity	0.037

Among the total sampled population, approximately half had access to a toilet in

their home. However, it was found that the majority of respondents who reported having a disability, 74%, had in-home access to a toilet. The prevalence of in-home access explains why people with disabilities, as a group, spend less time traveling from their homes to access toilets, and use toilets that are cleaned more frequently than the general population. Health also appears to correlate with access to water and sanitation facilities. Though the p-value of 0.058, which expressed the relationship between health and in-home access to toilets, was just above the threshold needed to prove a correlation, the data shows that a clear majority of respondents, 78%, who reported having severe health conditions such as tuberculosis or HIV, had access to toilets in their homes. P-Values which were sufficiently low enough to prove correlations related to health are shown below in Table 4.

Table 4. Variables with statistically significant relationship to health with corresponding p-value

Variable A	Variable B	P-Value
Health	Frequency of toilet cleaning	0.037
Health	Travel time to access a toilet	0.006
Health	SMS use	0.009
Health	Overall technological capacity	0.007

Much the same as was seen with age and disability, the prevalence of in-home access to water and sanitation services among the severely ill results in this group experiencing shorter travel times to access toilets and using toilets that are cleaned more frequently than those used by the general population.

7.1.1 Technological Capacity of Mobility Challenged Respondents

The following section will discuss how socio-cultural traits associated with mobility challenges relate to the use of mobile phones in an attempt to understand the appropriateness of e-governance as a tool for mobility challenged populations to advocate for improved services. The results of the statistical analysis show that age, disability, and illness all negatively correlate with technological capacity. The City of Cape Town has established a number of

ICT based fault reporting systems, such as SMS enabled fault reporting, as a cheap and easy means of communicating problems to the municipality (City of Cape Town, 2009), but the use of this technology is beyond the ability of most elderly, disabled, or seriously ill respondents. It was discovered that the older a respondent, the less likely they are to communicate using SMS. Among the total sampled population, about 60% use SMS to communicate; however, among those older than 50 years, only about 25% send or receive SMS messages. The same trend was seen among the seriously ill, which is highlighted in Figure 8. While close to 70% of respondents who reported no major health problems use SMS to communicate, the figure steadily drops to about 30% among respondents who report having serious health issues. Similarly, close to 70% of respondents who are not disabled use SMS, compared to just over 30% of respondents with disabilities.

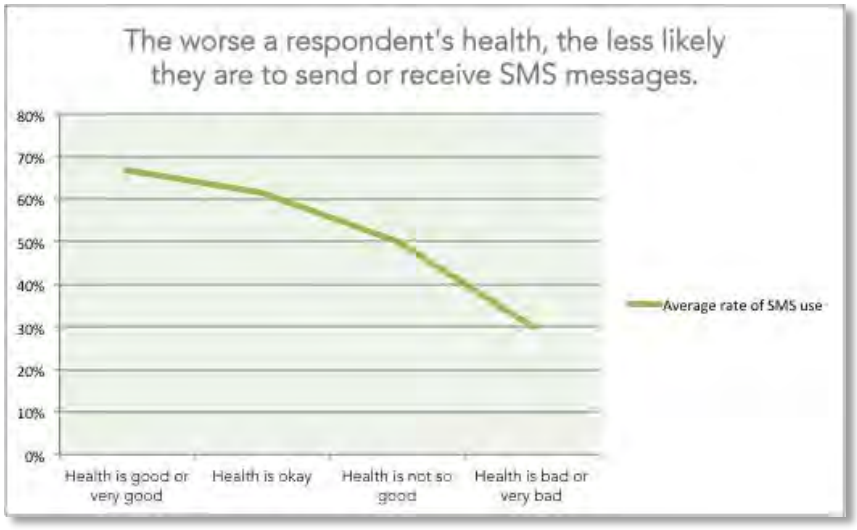


Figure 8. Graph showing declines in SMS use associated with poor health

Given the low rates of SMS use, it is not surprising that on the whole, physically challenged population use fewer mobile applications and have access to fewer mobile technologies than the general population. Respondents were asked to identify which of five mobile technologies they had available on their mobile devices – camera, radio, touch screen, voice recorder, and internet browser. Half of respondents over age 50 reported that they either had no phone, or their phones had none of the listed features. Meanwhile, as can be seen in Figure 9,

almost 40% of respondents aged 25 and younger report that they had all five features on their devices. Predictably, the number of mobile applications used decreases with age as well, as is shown in Figure 10. Out of a list of twelve commonly used mobile applications that included simple functions such as making voice calls, to more advanced options such as the use of facebook and mobile banking, among the 25 and under age group 63% use between seven and twelve applications; however, no one over 50 claimed to use more than six.

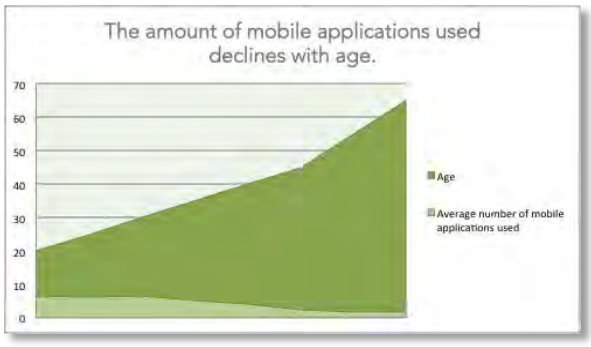


Figure 9. Graph showing relationship between age and the use of mobile applications

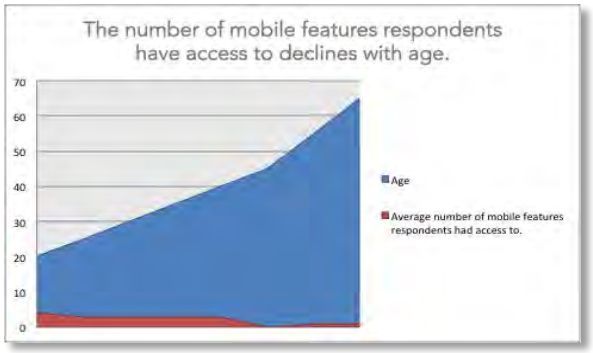


Figure 10 Graph showing relationship between age and access to mobile features

It was also discovered that rates of mobile phone ownership among disabled respondents is 20% lower than those who are not disabled, so it comes as no surprise that this group also uses fewer mobile features and applications. Every respondent with a disability claimed to either have no phone, or none of the five listed features, and over 70% claimed to use no more than two of the twelve listed mobile applications. Respondents with severe health issues also claimed to use few mobile features, with 78% claiming to have either no phone, or no more than two of the five listed features. Furthermore, 74% of those with poor health claimed to use only three or fewer of the twelve listed applications.

7.1.2 Discussion of Findings

The analysis of ICVI data revealed that people in the sampled population commonly hold negative opinions of young people. However, based on the collected data, there is no evidence that the stigmatisation imposed on young respondents hinder their ability to access services and ICT. Respondents twenty-

five years old and younger had among the highest rates of in-home access to water and sanitation services, and also exhibited high rates of mobile phone use and ownership.

The elderly are another age group that was found to have high levels of in-home access to services. That fact that the elderly, along with people with disabilities, and people with severe health problems tend to be found living in places with in-home access to water and sanitation facilities should not be seen as an indicator of privileges enjoyed by these groups. In reality, mobility challenged people are among the most marginalised in South Africa, especially in poor, black African communities. During the Apartheid Era, influx controls limited the ability of black Africans to settle in areas, such as Cape Town, which were designated as white only. However, because Cape Town and other South African cities depended on inexpensive black labour, there were systems in place to allow black labourers to temporarily settle in townships on the outskirts of cities, so long as they were able to secure legal employment. The requirement that black Africans be employed in order to live in Cape Town restricted the movement of physically challenged black Africans beyond what was experienced by the black African mainstream. Since those with physical challenges were not welcome in Cape Town, there was never a need to account for their needs when designing and building infrastructure.

What was apparent during visits to Imizamo Yethu, is that the needs of physically challenged populations are still not accounted for in the design of public water and sanitation facilities. The degree of difficulty these populations face in accessing public facilities becomes clear when looking only at those respondents who use public facilities. While overall, the elderly, people with disabilities, and people with severe health problems spend very little time traveling to access toilets, those among these populations who depend on public facilities spend considerably more time traveling than the general population. Not counting those with toilets in their home, the average Imizamo Yethu resident travels about 10 minutes from their home to get to an accessible toilet. However, as shown in Table 5, respondents with disabilities are on average

traveling about 14 minutes, those with severe health problems are traveling 15 minutes, and the elderly are spending on average 20 minutes to find an accessible toilet. Furthermore, those with severe health issues or disabilities were also found to be using toilets that are cleaned less frequently than the general population. Overall, Imizamo Yethu residents who use public facilities reported their toilets are cleaned on average once every 25 days, but respondents with disabilities stated that their toilets are cleaned, on average, only every 28 days, and those with serious health problems report their toilets are cleaned only every 35 days. While it is not clear from the collected data why the mobility challenged are using dirtier toilets than the general population, one theory is that their mobility issues lead to diminished earning potential. In turn, their financial situation may relegate them to the least desirable sections of the township, which offer the lowest quality of services.

Table 5. Average amount of time varous groups spend traveling to a toilet

Travel Time to Accessible Toilet

- General Population	10 mins.
- Population with Disabilities	14 mins.
- Population with Poor Health	15 mins.
- Elderly Population	20 mins.

Frequency of Toilet Cleaning

- General Population	25 days
- Population with Disabilities	28 days
- Population with Poor Health	35 days

When looking only at respondents who use public facilities, it becomes clear that mobility challenges lead to a reduced quality of access to water and sanitation facilities, which may discourage these populations from settling in the municipality. This theory is supported by research by Maart et al. (2007), which shows that it is more challenging for disabled people to live in an informal area of Cape Town than rural areas of the Eastern Cape (which is where most Imizamo Yethu residents originate), due to significant barriers in the City's

natural and built environment that prevent access to public buildings, transportation, services and technology (Maart, et al. 2007). Similarly, a study by Clark, et al. (2007) analysed the relationship of mortality and migration between rural and urban areas in South Africa, and found that migrants who experience a serious illness or injury in the place they have gone to find work, would often return to their rural homes, because urban areas presented physical and social barriers to convalescence. Furthermore, a study out of the US also found that mobility problems result in a reduced willingness to encounter environmental challenges, such as climbing stairs, crossing busy streets, and stepping over curbs (Shumway-Cook, et al., 2003). Access to public toilets in Imizamo Yethu often involves squeezing through narrow passageways, climbing un-paved paths, and crossing pools of mud and water that are bridged with planks and stones. The toilets themselves lack any sort of railing or other assistive features that might be needed by people with mobility challenges. It can be assumed that if people with limited mobility avoid stairs and curbs, they would probably avoid (or simply not be able to access) most public water and sanitation facilities in Imizamo Yethu.

The fact that essential services are largely inaccessible to mobility challenged populations could explain why so few of them use public facilities, and are hardly found in Cape Town's black African townships. The data presented in this study is not sufficient to prove that circular migration in South Africa is a result of poorly designed water and sanitation infrastructure. It is likely that circular migration exists for a number of complex reasons, of which the built environment is just one. However, the analysis is helpful for placing the municpality's water and sanitation infrastructure in a historical context of exclusion and population control, and provides evidence that the infrastructural design contributes to the perpetuation of entrenched social controls. The data clearly shows that mobility challenges significantly impact access to water and sanitation services in Imizamo Yethu, and has a particularly negative influence on respondents' ability to use public facilities. It appears that among this population, the pattern of access to public water and sanitation services parallels their access to ICT in the sense that mobility challenges negatively impact both.

7.2.0 Education

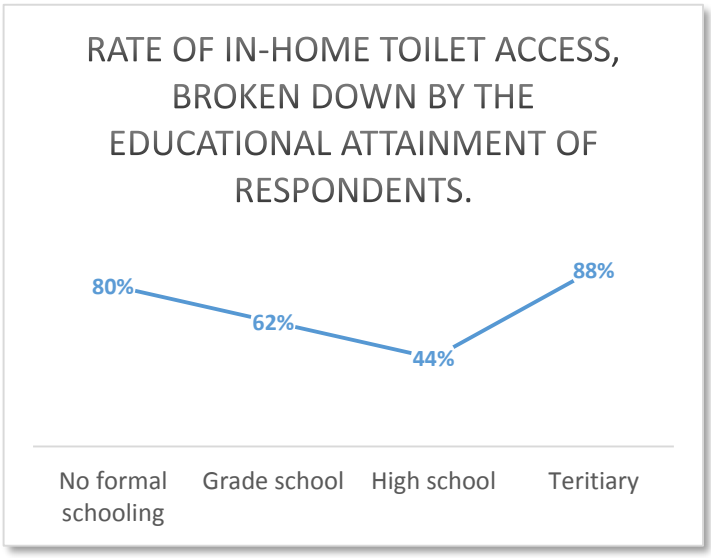
Education was a socio-cultural factor that was found to have statistically significant correlations with several water, sanitation, and ICT variables, which are highlighted in Table 6.

Table 6. Variables with statistically significant relationship to education with corresponding p-value

Variable A	Variable B	P-Value
Education	In-home access to a toilet	0.011
Education	Satisfaction with toilets	0.025
Education	Disruption of service	0
Education	Mobile phone ownership	0.005
Education	Mobile phone use in the past week	0.004
Education	SMS use	0.006
Education	Overall technological capacity	0.02

Though it was not necessarily a surprise that a person's education affects their access to water and sanitation services, since educational attainment is assumed to lead to higher standards of living, it was unexpected to find respondents with a high school education being the least likely cohort to have a toilet in their home. As can be seen in Figure 11, only 44% of those with a high school education reported having in-home toilet access. In contrast, 62% of those with only a grade school education have a toilet in their home, while 80% and 88% of respondents with no schooling and a tertiary level education respectively claimed to have in-home toilet access.

Figure 11. Differences in in-home access to toilets between different groups based on their educational attainment in Imizamo Yethu.



Respondents with a high-school education also experience more frequent water shutoffs than those with no formal education or just a grade school education,

which is shown in Figure 12. Almost 40% of respondents who reported high school as their highest level of education experience water shutoffs either daily or weekly, whereas only 3% and 15% of respondents with either no schooling or only a grade school education respectively experience disruptions this frequently. Unsurprisingly, those with a tertiary education also experience water shutoffs infrequently with 71% reporting that their water is almost never shutoff.

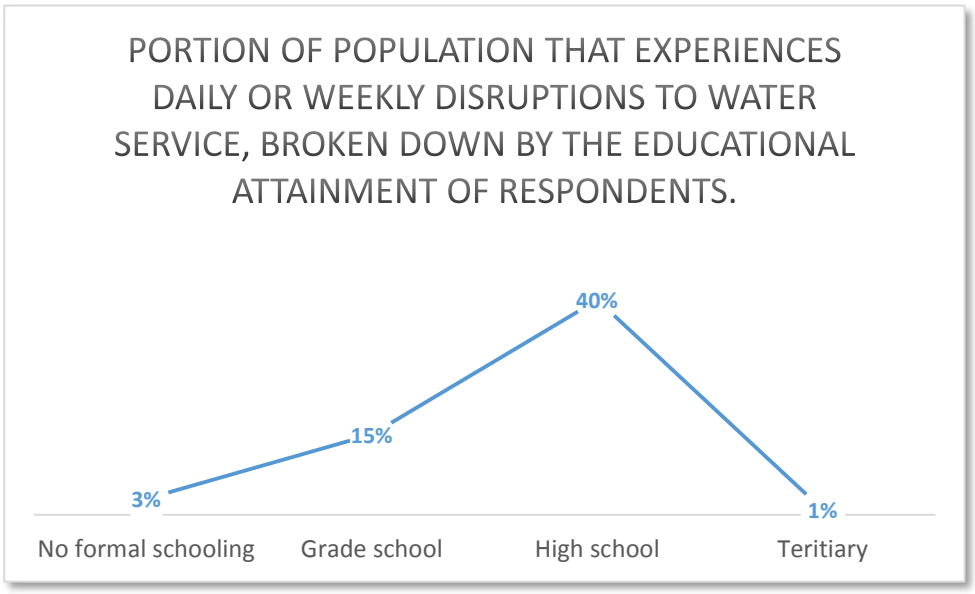


Figure 12. Differences in water service reliability between different groups defined by their educational attainment.

Education has a direct correlation with people's satisfaction with public sanitation facilities. When looking only at those respondents who use public toilets, it was observed that the more education a respondent has received, the less likely they are to be satisfied with the condition of public toilets. Half of those who have received no formal education found the toilets to be in a satisfactory state; however, this figure steadily declines with educational attainment, with no respondents with a tertiary education believing public facilities to be in a satisfactory state. This decline in satisfaction is shown in Figure 13.

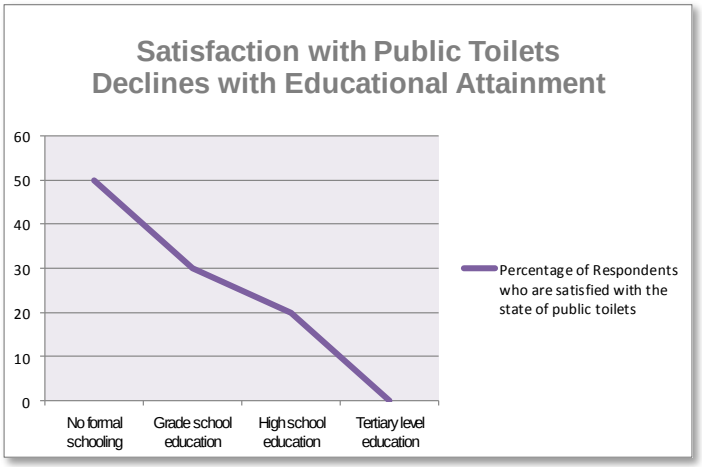


Figure 13. Graph showing satisfaction with public toilets among different groups defined by their educational attainment

Education also appears to have a relationship with mobile phone ownership and use. The percentage of the overall population that owns a mobile phone is 87%. However, only 80% of those with no schooling and 75% of those with a grade school education own mobile phones. In addition to lower rates of mobile phone ownership, it was observed that these cohorts use mobile phones less frequently than the general population, even when mobile phone ownership is not a factor. Only 70% of those with no schooling and 63% of those with only a grade school education had reported using a mobile phone for any reason in the week prior to being interviewed. This compares starkly to those with higher levels of education, who were much more likely to have used a mobile phone in the week prior to being interviewed. Among those who had received a high school education, 90% had reported using a mobile phone in the past week, as did 100% of those with a tertiary education.

Given that respondents who have received little to no formal education are less likely to own or regularly use a mobile phone, it comes as no surprise that they also communicate less frequently using SMS than their more educated neighbours. Only 40% of respondents with no schooling, and only slightly more among those with a grade school education, claim to use SMS. This is compared to nearly 70% of respondents with a high school education and 75% of respondents with a tertiary education. Not surprisingly, education also correlates with the number of mobile features and applications used by respondents. When asked what mobile features a person had on their phone,

respondents with no schooling or a grade school education claimed to have, on average, less than two. Respondents with a high school education reported to have around three, and those with a tertiary education had more than four.

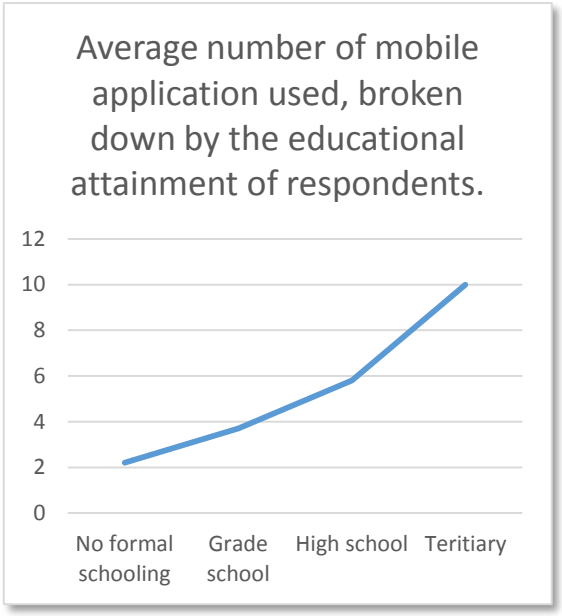


Figure 14. Graph showing differnces in number of mobile applications used among different groups defined by their educational attainment

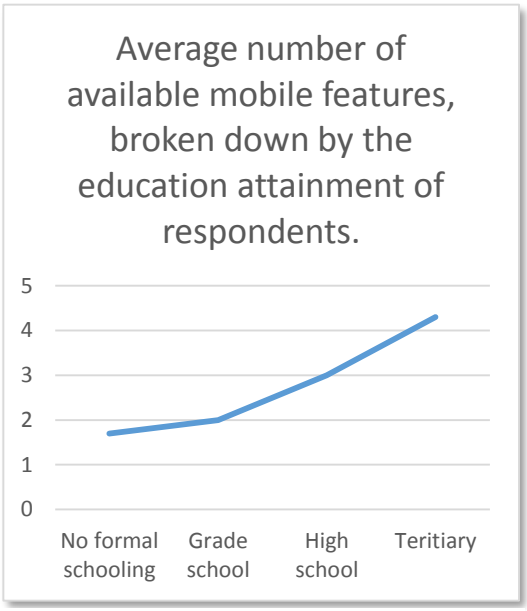


Figure 15. Graph showing differnces in number of accessible mobile features among different groups defined by their educational attainment

Out of a possible twelve mobile applications, respondents with no formal schooling, on average, use slightly more than two, those with a grade school education use about three, those with a high school education use about six, and respondents with a tertiary education use around ten. The data shows that education is positively correlated with ICT use, which supports the findings of Medhi, et al. (2010), suggesting a fundamental cognitive shift taking place around Grade six in a k-12 education system, which allows people to more effectively use ICT.

Though education was found to shape access to both water and sanitation services, and ICT, the patterns of disparity do not seem to mirror one another. The cohort of respondents with a high school education appears to be most marginalised in terms of access to water and sanitation services, yet their technological sophistication is second only to the cohort with a tertiary education. Elderly respondents tend to be among the least educated in Imizamo

Yethu; 62% of respondents over 50 years old have no more than a grade school education. As has been noted, the elderly have disproportionately high levels of in-home access to toilets and water. This helps explain why those with little to know formal education have higher rates of in-home access to services than those with a high school education.

7.3.0 Income

Employment and the receipt of government grants were used as indicators of income to identify correlations between income, and access to water, sanitation, and mobile technology. The only variable found to have a significant relationship to employment was frequency of toilet cleaning, which is shown in Table 7. It was found that a large majority of the unemployed, 77%, reported their toilets are cleaned every day, whereas only 23% of those with jobs made this claim. It appears that this is related to the fact that almost all respondents 50 years or older are unemployed, the study did not differentiate between retirement and other forms of unemployment, so it turned out to be a less than perfect indicator of income and poverty.

Table 7. Variables with statistically significant relationship to employment with corresponding p-value

Variable A	Variable B	P-Value
Employment	Frequency of toilet cleaning	0.007

Data on the receipt of government grants provides a bit more insight into how respondents' financial situation affects access to services and ICT. Variables with a relationship with the receipt of grants are highlighted in Table 8. The data indicates that there is a statistically significant correlation between receiving government grants and the amount of time spent traveling to access a toilet. Surprisingly, there was virtually no difference in the rate of in-home access to toilets among grant-recipients and non-recipients. However, when looking at those without access to toilets in their home, travel times are slightly longer

among those who depend on government grants. On average, recipients spend about 12 minutes traveling from home to toilet, compared to about 10 minutes among non-recipients. Grant recipients also tend to use fewer mobile applications than those who do not receive a grant. Only 24% of the grant receiving population uses more than seven applications listed on the survey, compared to 42% of those who do not receive a grant. There were only slight insignificant differences between the two groups in the number of features available on mobile phones.

Table 8. Variables with statistically significant relationship to the receipt of government grants with corresponding p-value

Variable A	Variable B	P-Value
Receipt of government grant	Travel time to access a toilet	0.003
Receipt of government grant	Overall technological capacity	0.017

7.3.1 Discussion of Grant Recipients

A p-value of 0.003 indicates that dependence on government grants and age are correlated. Seventy percent of respondents over 50 years old receive some form of government grant, and while it may be expected that the elderly are the reason grant recipients use so few mobile application, even if the 51 and older age group is excluded, a p-value of 0.021 indicates that there is still a relationship between grants and the number of mobile applications used. The results show that 54% of grant recipients under the age of 51 either have no phone or use no more than three mobile applications. In contrast, nearly 70% of non-recipients use more than three applications.

The receipt of government grants may be indicative of diminished purchasing power, as they are intended to assist low-income individuals with the financial strain of old age, disability, and parenthood. It is unlikely that unemployment among respondents under 50 years old would be due to retirement, and the unemployment figures of those under 50 suggest that younger grant recipients face severe levels of unemployment. The unemployment rate is just under 80% among grand recipients, while that of non-recipients is around 65%. Furthermore, grant recipients are also more likely to have large families than

non-recipients. Nearly a quarter of grant recipients have 6 or more family members to support, compared to less than 10% of non-recipients. In summation, for those who are dependent on grants, high unemployment combined with large families could equate to financial strain, which could explain why this group uses fewer mobile applications than the general population, since presumably they would have less income to spend on the data needed to run applications such as mobile internet or Facebook.

7.4.0 Length of Residency in Imizamo Yethu

Table 9. Variables with statistically significant relationship to length of residency in Imizamo Yethu with corresponding p-value

Variable A	Variable B	P-Value
Length of Residence in IY	In-home access to water	0.004
Length of Residence in IY	In-home access to a toilet	0
Length of Residence in IY	Overall technological capacity	0.003

The amount of time a person has lived in the community appears to have a relationship with their access to water and sanitation services, as well as their technological capacity. A list of variables related to length or residency is shown in Table 9. Length of residency in Imizamo Yethu was found to correlate with in-home access to water and toilets, as well as the use of mobile features and applications. On average, respondents who lack a water tap and/or toilet in their home have lived in the township for about eleven years, whereas those with access to water and/or a toilet in the home have lived there for almost sixteen years. As is shown in Figures 16 and 17, on average, the longer a respondent has lived in Imizamo Yethu, the fewer mobile applications they are likely to use, and the fewer mobile features they are likely to have access to, which is evidenced by a p-value of 0.003. Those who have lived in Imizamo Yethu for five years or less tend to use around six applications and have access to about three out of the five listed mobile features. That number steadily declines with years spent in the township. Those who have lived in Imizamo Yethu since its founding in 1991 use on average about three out of twelve applications and have access to just two of the five mobile features.

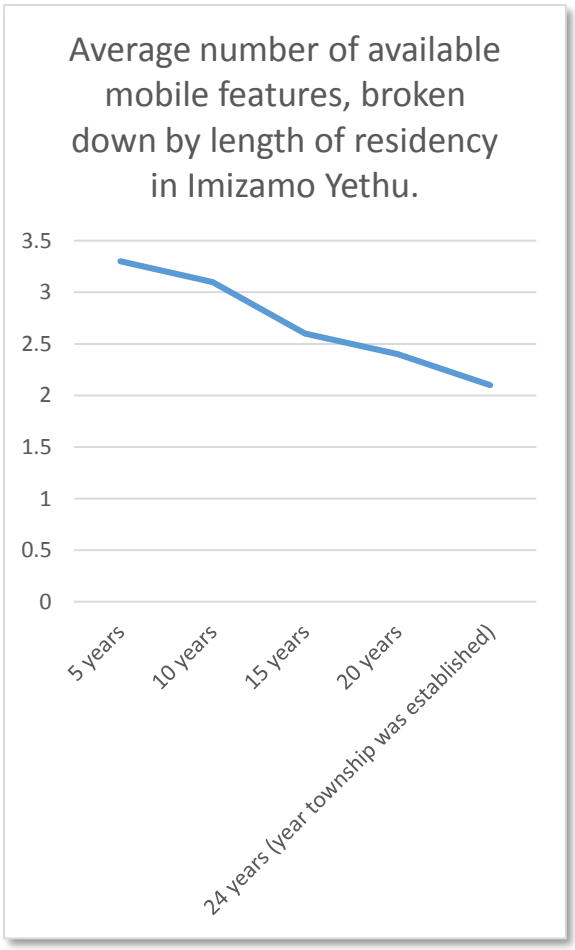


Figure 16. Graph showing relationship between length of residency in Imizamo Yethu, and the number of available mobile features.

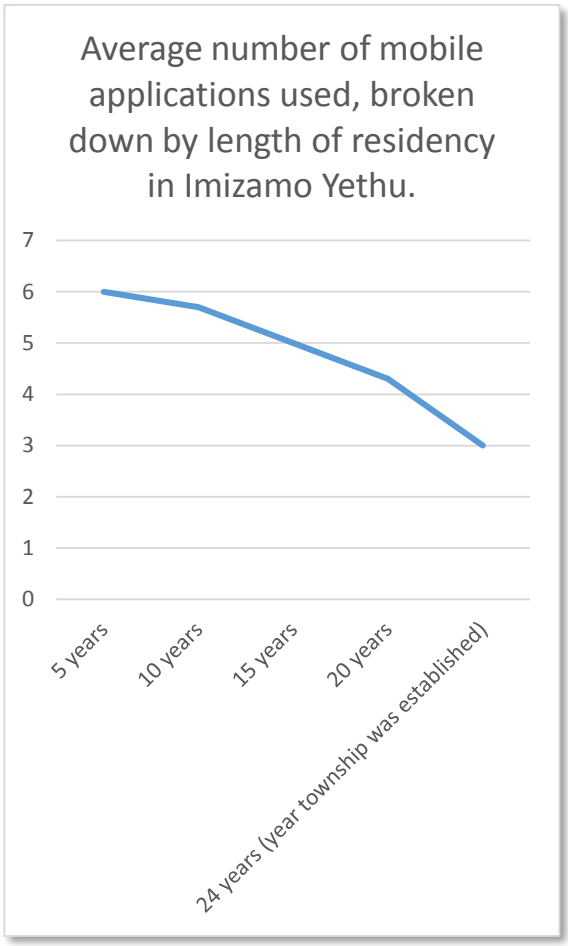


Figure 17. Graph showing relationship between length of residency in Imizamo Yethu, and the number of mobile applications used.

Respondents who have lived in Imizamo Yethu for twenty years or more are among the original founders of the township. They moved to the area before it became overcrowded, and were likely entitled to formal housing. Access to formal housing would explain the high rates of in-home access to amenities this group enjoys. Those who have lived the longest in Imizamo Yethu, also tend to be older than those who are newly arrived. The median number of years that respondents reported living in the township is fifteen, the average age of those who have lived in the township fifteen years or less in thirty-two, while the average age of those who have lived there fifteen years or more is forty-two. This is likely the reason technological capacity is negatively correlated with years spent in Imizamo Yethu. If respondents age fifty years and older are excluded, the length of residency in Imizamo Yethu has essentially no impact on the number of mobile applications used or the number of available mobile features.

7.5.0 Citizenship

Citizenship, which was determined by dividing the sample population into two groups, those born in South Africa and those who were not, was found to correlate with in-home access to water, travel time to access services, frequency of water service disruptions, and being assaulted while using facilities. These correlations can be found in Table 10.

Table 10. Variables with a statistically significant relationship to citizenship with corresponding p-values.

Variable A	Variable B	P-Value
Country of birth	In-home access to water	0.006
Country of birth	Travel time to access water	0.002
Country of birth	Disruption of service	0.023
Country of birth	Frequency of toilet cleaning	0.001
Country of birth	Assault	0.006

The analysis of data collected by ICVI revealed that citizenship is a socio-cultural variable that has stigma attached to it. Many South African born respondents reported feeling threatened by foreigners, and foreign born respondents often felt the same way about their South African neighbours. Therefore, it was not surprising to find differences in access based on citizenship. It was observed that foreign born respondents are much less likely to have access to water in their home than their South African born counterparts; the percentage of South Africans with water piped to their home is 69%, while the percentage of foreign-born respondents with in-home water access is much lower, at just 37%. Though foreigners are unlikely to have in-home access to water, they generally live within a short distance of a water tap, much more so than South Africans who depend on public taps. The data shows that 19% of South Africans without a water tap in their home travel more than five minutes to access water, compared to only 5% of foreign born respondents. While foreign-born respondents are less likely to have water piped to their home, they are also less likely to experience frequent water shutoffs. Sixty-eight percent of foreign-born respondents claim to almost never experience water shutoffs, while just 32% of South African

respondents reported the same.

As a result of the disparate access to in-home facilities, foreign born respondents use toilets that are cleaned less frequently than South Africans. Nearly 60% of foreign respondents reported their toilets are cleaned once a week, but the same percentage of South Africa born respondents claimed theirs are cleaned nearly every day. Interestingly, being born outside the country was the only variable that was associated with being assaulted while using public water and sanitation facilities. As can be seen in Figure 18, nearly 30% of foreign born respondents reported being assaulted while using facilities, only 12% of South African reported the same.

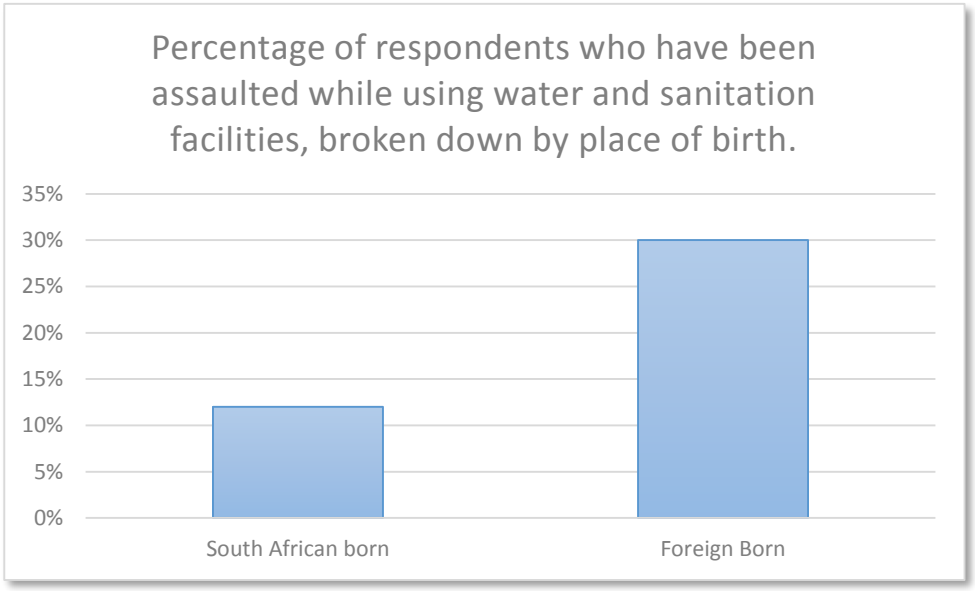


Figure 2 Graph showing relationship between assault and citizenship

While citizenship was found to correlate with access to water and sanitation services, it was not found to correlate with access to ICT in any way. The reason that foreign born respondents have low rates of in-home water access, may stem from their inability to benefit from government housing programs, which limits their opportunities to obtain formal housing in the township. A study by Dodson and Oelofse (2013) revealed that foreign residents of Imizamo Yethu are generally wealthier than their South African neighbours. This may allow them to obtain informal housing in desirable locations, which would explain why they spend less little time traveling to access water, and experience few disruptions to

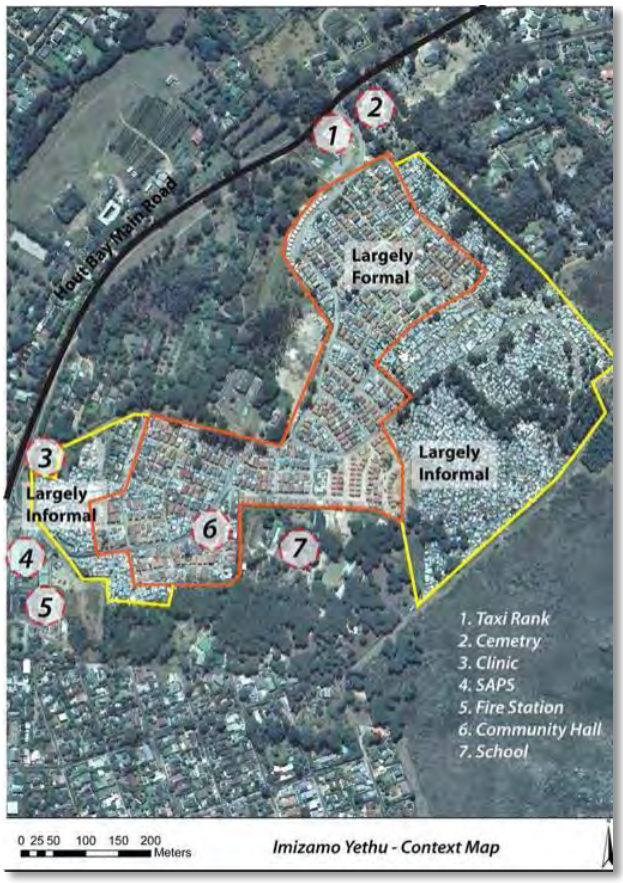
service compared to South Africans who depend on public facilities. Despite being close to services, it seems a dependence on public facilities puts foreigners in a vulnerable position, as evidenced by the frequency at which they are attacked when using public water taps and toilets.

7.6.0 Gender, Dependents, & Stigmatisation

The decision to test for variables that correlate with the number of dependents a person cares for was made because a wide range of family sizes was observed during initial site visits to the community. It was hypothesized that family size may be indicative of underlying socio-economic forces, which could affect access to water and sanitation services or ICT. However, no water and sanitation variables, or ICT variables were found to correlate with family size. Since this was not a variable identified by other researchers to determine access to water and sanitation services, or ICT, it was not necessarily surprising that no correlations were found.

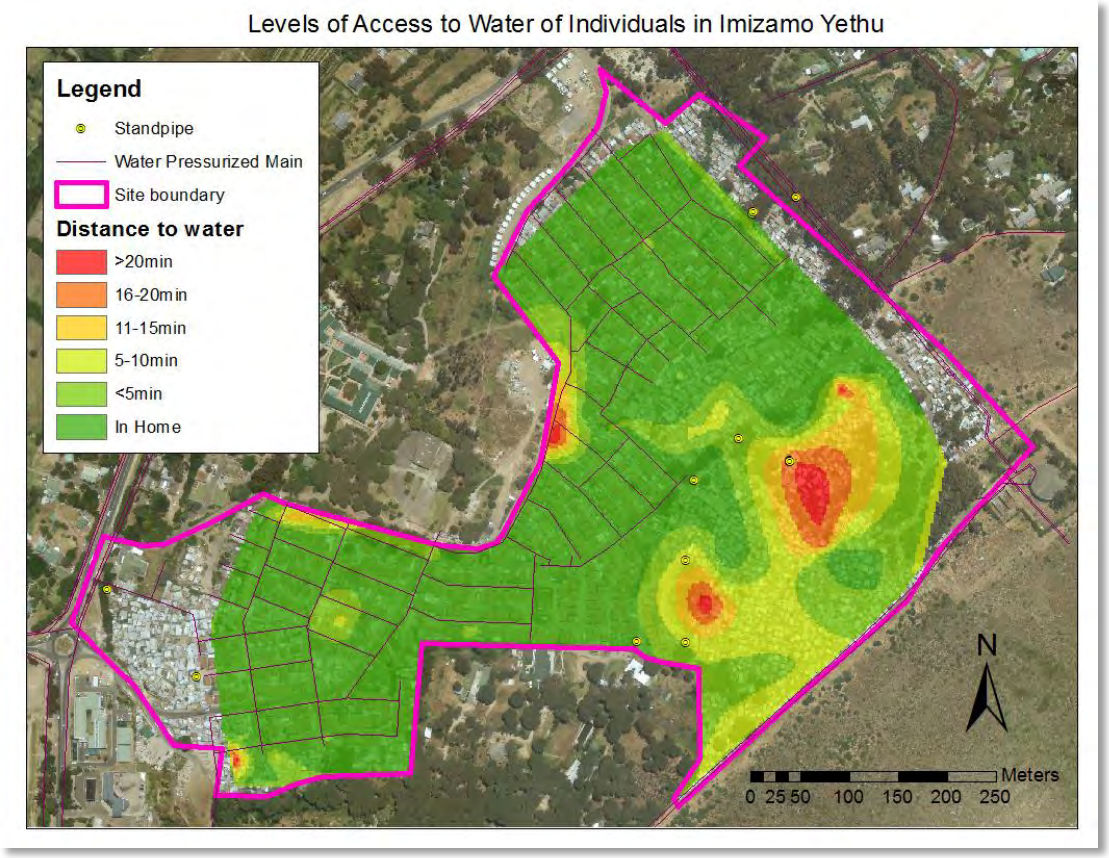
Given the wealth of literature identifying gendered digital divides as well as gendered access to water and sanitation, and the fact that ICVI revealed a local stigma attached to men, it was surprising to discover that gender appears to have no impact on ICT use or access to water and sanitation services in Imizamo Yethu. Interestingly, membership in any of the analysed groups that were found to have a stigma attached to them – men, youth, and groups characterised by citizenship – does not appear to negatively impact ICT use, and only foreign citizenship was found to negatively correlate with access to water and sanitation services. Though many people expressed negative feelings toward youth, respondents under twenty-five years were found to have some of the highest rates on in-home access to water and toilets, and were some of the most sophisticated mobile phone users in the sample population.

8.0 Spatial Analysis



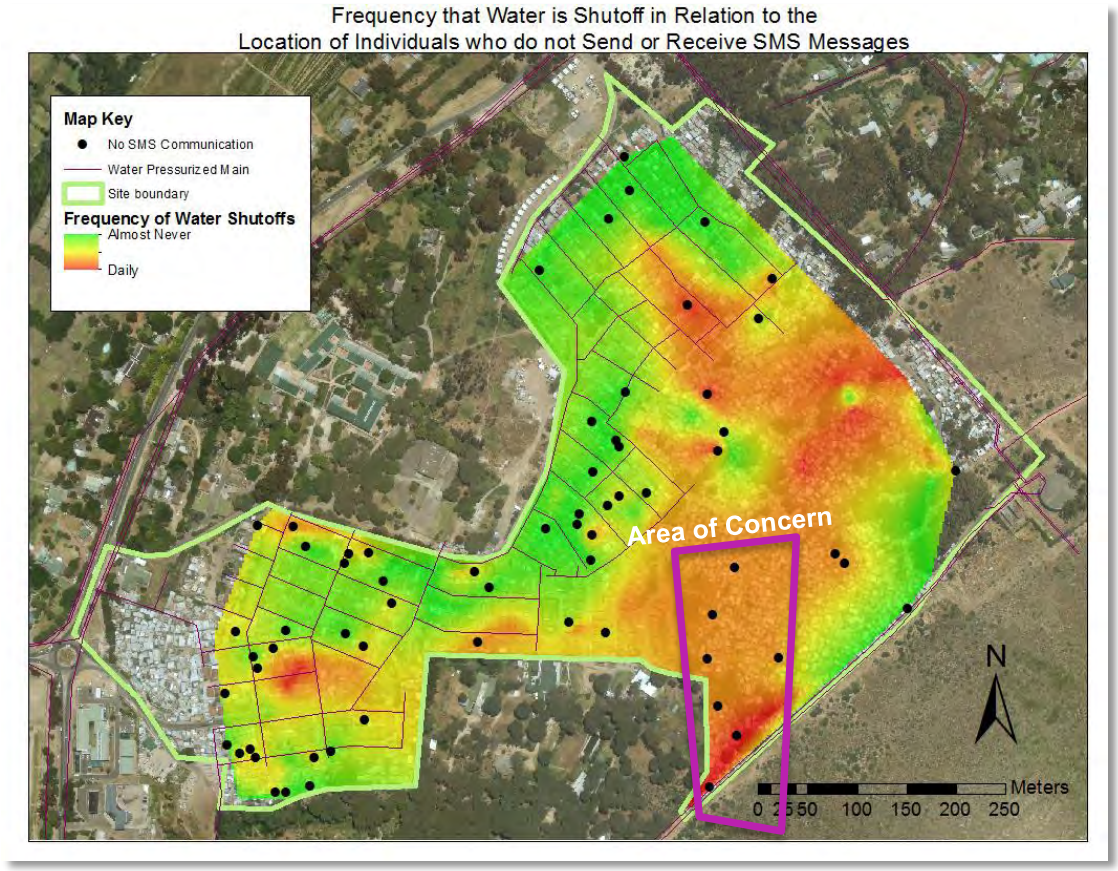
Map 5. Map provides a reference for understanding the layout of Imizamo Yethu, particularly regarding the location of informal settlements. Map created by Rosenberg (2013).

In order to understand geographic disparities in access to services and ICT, ArcGIS was used to spatially analyse disruptions to water delivery service, and SMS use. The results identify a geographic digital divide within the township, and highlights where it overlaps with inadequate service delivery, giving an idea of where service delivery problems may not get reported to municipal officials. During field surveys, the location of each interviewed person's house was marked on aerial photographs of the township using a unique number that corresponds with a completed survey. This allowed for the assignment of geographic coordinates to the collected data. Ebrahim (2014:a) used this data in a related study to map socio-cultural factors affecting travel time to access water. Using a template from that study, data on water service disruptions and SMS use were compiled into maps.



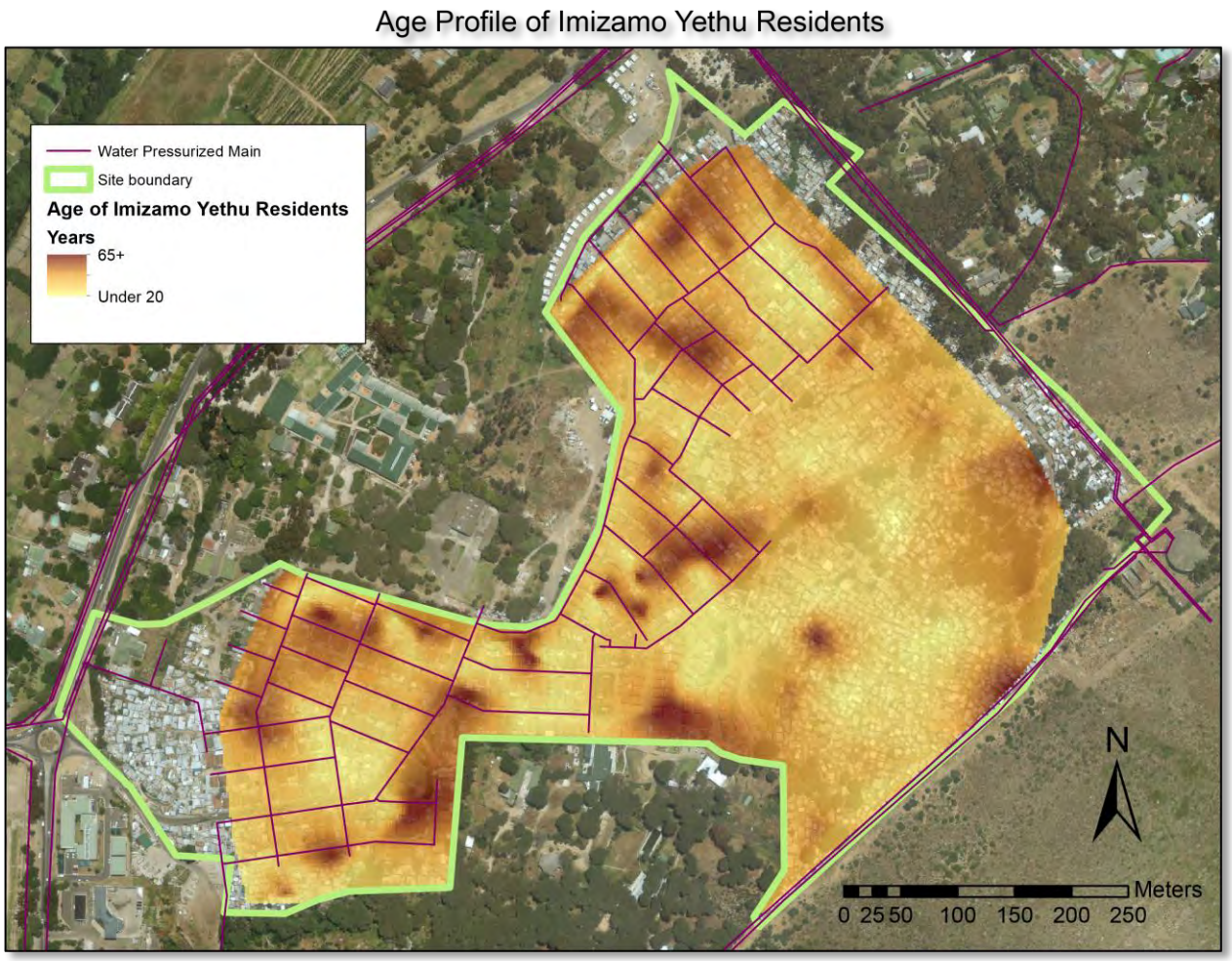
Map 6. Map created by Ebrahim (2014:b) spatially highlighting time spent traveling to access water. This map was used as a template for subsequent maps. The map clearly shows that people who live toward the centre of the informal settlement spend the most time traveling to water. The map also indicates that respondents living closest to public standpipes spend the most time traveling to access water, but the presence of standpipes does not necessarily equate to water access. It should be noted that the map only shows standpipes installed by the City of Cape Town. These standpipes are only located in informally settled areas; elsewhere in Imizamo Yethu most people have access to water in their homes. Also, many people illegally tap into municipal water mains to install makeshift standpipes. Standpipes, though officially public, are sometimes claimed exclusively by a select group of people, who deny others use of the amenity. It should also be noted that these standpipes are not necessarily functioning. The state of standpipes, was not covered in the scope of this study.

According to the generated map, informal areas appear to experience water shutoffs much more frequently than formal areas, yet there appears to be more respondents who use SMS in the informal areas of the township compared to the formal. Despite the preponderance of SMS use in the informally settled parts of Imizamo Yethu, an area was identified that contains several respondents who reported not using SMS to communicate, this area was also found to experiences very frequent disruptions to water service delivery. The map suggests that residents in this area are disadvantaged in terms of service delivery, yet face barriers to communicating their needs to municipal officials.



Map 7. Area of Concern with a cluster of respondents who reported not using SMS and experience frequent water shutoffs.

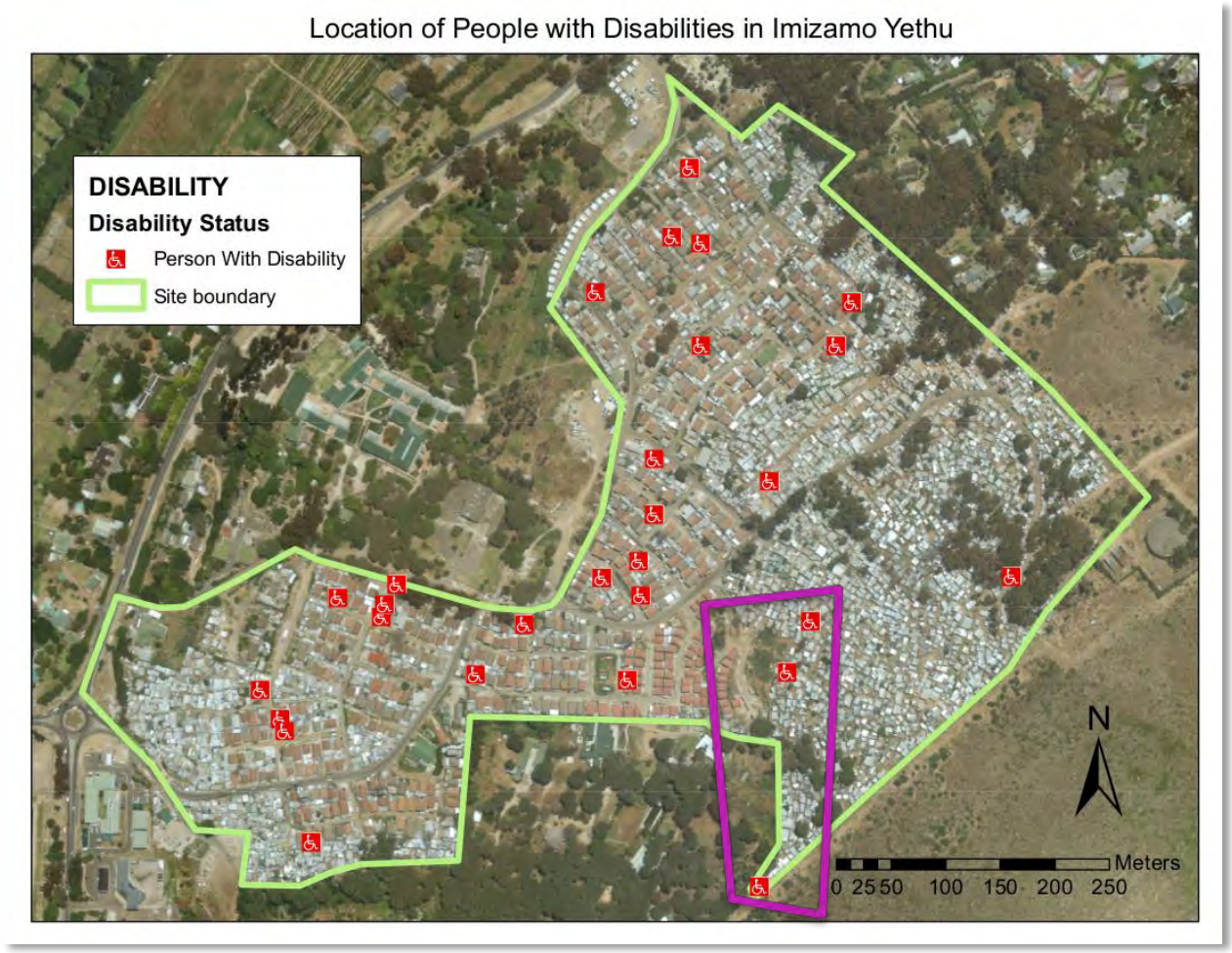
The results of the spatial analysis show that even within relatively poor communities, there are spatial differences in the uptake of technology. Imizamo Yethu's geographic digital divide appears to have a lot to do with the fact that mobility challenged individuals are largely concentrated in certain sections of the township. Map 8 shows that elderly people tend to be found primarily in the more formal sections of the township, which are located along the water pressurised mains shown on the maps. Map 9 shows a similar settlement pattern among people with disabilities. As was discussed in previous sections, this is likely due to the infrastructure of the informal areas being largely inaccessible to those with mobility challenges. The results of the statistical analysis show that these populations have a significantly lower technological capacity than the general population of Imizamo Yethu, which explains why the majority of respondents who do not use SMS are not located in the township's informal settlements.



Map 8. Older populations tend to be concentrated in more formal and developed parts of the township.

The area of concern that was highlighted in Map 7 stands out from the rest of the township in the sense that it is an informal area, yet is home to a significant disabled population. However, the disabled population in this area is not large enough to account for all the respondents living there who do not use SMS. It is not clear from the collected data why this section has such a high concentration of respondents who do not use SMS. The area is one of the most difficult to access sections of the township, due to the steep terrain and distance from roads, which combined with the unreliability of services may indicate that this is an area of last resort, housing those without the means live anywhere else. If this is the case, it could mean that the digital divide seen here may result from economic deprivation, which would suggest that Graham's (2002) observations on intraurban digital divides between wealthy and poor city dwellers can be seen even within areas with relatively low levels of income inequality. Though it

is not possible to identify a definitive cause for this digital divide based on the collected data, it is clear that there is an overlap of service delivery failure and low technological capacity in this section of Imizamo Yethu.



Map 9. People with disabilities tend to be found in more formal areas of Imizamo Yethu.

9.0 Conclusion & Recommendations

The aim of this study was to identify socio-cultural traits that shape access to water and sanitation services, as well as mobile technologies, in an attempt to understand if populations who are marginalised in terms of access to services have the technological capacity to advocate for improvements using the City of Cape Town's electronic fault reporting systems. This is important given that the current state of the municipality's water and sanitation system is characterised by unacceptable levels of inequality, and the introduction of ICT into the system is likely to amplify whatever social forces shape the system, particularly if those who lack adequate access to services also lack the skills or hardware needed to communicate with service delivery providers.

	Water & Sanitation Variables											ICT Variables					
	In-home access to water	In-home access to toilet	Travel time to water	Travel time to toilet	Satisfaction with water quality	Satisfaction with public toilets	Frequency of water service disruptions	Wait time to use public facilities	Frequency of toilet cleaning	Assaulted while using public facilities	Mobile phone ownership	SMS Use	Calling	Phone use in week prior to being interviewed	Overall technological capacity (mobile apps and features)	Socio-cultural variable affects access to water & sanitation, as well as ICT
Age	x	x	x	x				x	x			x			x	YES
Gender																NO
Health				x					x			x			x	YES
Disability		x		x					x		x	x			x	YES
Stigmatisation																NO
Geography							x					x				YES
Citizenship	x		x				x		x	x						NO
Income				x			x								x	YES
Education		x				x	x				x	x			x	YES
Length of residency in Imizamo Yethu	x	x													x	YES
Number of Dependents																NO

Table 11. Water and sanitation, and ICT variables that correlate with various sociocultural traits.

Table 11 highlights each analysed socio-cultural trait and the water and sanitation, and ICT variables that were found to be associated with them. The results of the study show that age, health, disability, geography, income, education, and length of residency in Imizamo Yethu, are all socio-cultural determinants to water and sanitation access, and ICT use. Factors related to mobility challenges - age, disability, and health – correlate negatively with access to services and technology, meaning that older, sicker, or disabled respondents were likely to experience barriers to accessing public water and sanitation facilities, as well as use fewer mobile features and applications. Interestingly, these variables, along with education, were the only ones that were found to determine SMS use. Income also appears to be a determinant to access to services and technology, the results of the data analysis show that respondents who are dependent on government grants spend more time traveling to access toilets, and use fewer mobile features and applications despite mobile phone ownership rates nearly on par with the general population.

Length of residency in Imizamo Yethu was also found to be a determinant to access. While, it was observed to negatively correlate with ICT use, meaning that the longer a respondent has lived in the township, the fewer mobile applications and features they are likely to use, it seems to have a positive association with access to water and sanitation. It was observed that rates of in-home access to water and toilets increases with the number of years lived in the township. While length of residency appears to correlate positively with access to water and sanitation but negatively to ICT, education appears to do just the opposite. It was observed that more educated respondents were less likely to be satisfied with the state of public toilets, and were less likely to have a toilet in their home, and were more likely to experience frequent water disruptions. However, they were also more likely to send and receive SMS messages and use more mobile features and applications than those with lower levels of education. The few respondents with a tertiary education were the exception to the negative correlation between education and access to water and sanitation, as these respondent generally had water taps and toilets in their homes.

Surprisingly, stigmatisation does not appear to be a determinant to access in Imizamo Yethu. Citizenship was the only socio-cultural variable associated with stigma that correlated with any water and sanitation variables. These results were unexpected given that men were identified as a stigmatised group, and research has commonly cited gender as being a primary factor in determining access to water, sanitation, and ICT, especially in the Global South. Though the findings appear to contradict studies focusing on gendered digital divides, it appears to compliment studies on stigmatised populations' ICT use, which suggest that these populations use technology differently than the mainstream, but not necessarily less. In fact, gender and citizenship were the only variables beside 'number of dependents' that had no impact on ICT use. Age was found to be a determinant to ICT use, but it correlates negatively, meaning that the youth– which were identified as a stigmatised group – are some of the most empowered mobile phone users in the community. Based on the results of this study it appears that the imposition of stigma on a group does not necessarily determine their access to services or ICT. Rather, it is the characteristics of particular stigmatised populations which impact their access and use.

Finally, the results of the GIS analysis revealed that geography is a determinant to access in Imizamo Yethu, both in terms of water and sanitation, and ICT. It appears that for the most part, marginalisation in terms of ICT use does not spatially overlap marginalised access to water. Respondents living in informally settled areas of Imizamo Yethu are the most affected by disruptions to water services, however rates of SMS use were found to be higher in these areas than in formally settled sections of the township, where most people have access to water in their homes. However, an informally settled area in the southeast corner of the township appears to buck this trend. This area experiences some of the most frequent water delivery disruptions, and also has a lower rate of SMS use than adjacent portions of the township.

9.1.0 Discussion

Within South Africa, discussions around inequality tend to focus on differences based on wealth and race. However, this study sought to identify differences that exist within a low-income, almost racially homogeneous township, to see what socio-cultural factors beyond race and income shape access to services and technology. It was revealed that age, physical ability, and health are all major factors that define access. The fact that these factors turned out to be so influential is not surprising given that the built environment was not designed to accommodate people with limited mobility. South African townships are a product of apartheid era influx controls that ensured only economically active black Africans were living in so-called 'white areas' such as Cape Town. The built environment was not designed for mobility challenged populations as they are typically not economically active, and therefore were not welcome in Cape Town. However, in a post-apartheid era, government subsidised housing allows for some mobility challenged individuals to find the support they need to access essential services in Imizamo Yethu, yet the scarcity of formal housing leaves a huge portion of the townships dependent on public facilities, which do not support the needs and abilities of older, disabled or otherwise mobility challenged persons.

By framing influx controls not just as a restriction on the movement of black people, but more specifically as a restriction on the movement of unemployable black people, than it becomes clear that these controls, though no longer law, continue to be socially entrenched. Service delivery systems are a product of the societies that design and manage them, so it should come as no surprise that the black elderly, people with disabilities, and the infirm face extreme obstacles to accessing life sustaining services such as water and sanitation delivery. These obstacles discourage people with limited mobility from settling in Imizamo Yethu, contributing to a situation where virtually only those who are young and reasonably healthy, or 'employable', are found to be living in the township. What is perhaps most distressing is that these populations are essentially silenced by the use of e-governance, as they lack the capacity to communicate through

mediums such as SMS, email, and social media. These populations exist on the very fringes of the Network Society, where they lack the skills and hardware needed to exert power and affect change. The municipality's management of essential services should encourage social transformation, but given the challenges these populations face in using the tools needed to advocate for improvements, ICT based fault reporting appears to perpetuate the status quo. This helps explain why after 20 years of democracy, Cape Town's water and sanitation infrastructure still reflects the structural inequalities of the apartheid era.

In addition to sidelining people with mobility challenges, it appears that ICT enabled fault reporting likely amplifies the marginalisation of certain places where service delivery failures spatially overlap areas that are disconnected, or under connected to telecommunications networks. However, it should be noted that while such an overlap was identified in Imizamo Yethu, it is also true that this overlap accounts for a relatively small portion of township's landmass. The most severe service delivery problems exist in the township's informal settlements, yet SMS use appeared to be common in most sections of the informal settlements. Technically speaking, most residents of these areas should be able to access the City's SMS based fault reporting system. Furthermore, the more highly educated members of the township and the youth are also technologically prepared to use mobile phone enabled fault reporting. Considering that South Africa is demographically very young, 37% of the country's population is between the ages 15 and 35 (Statistics South Africa, 2012), it seems that some of the age based disparities in access to technology may gradually decrease as younger, tech saavy generations replace those who have struggled to adopt ICT.

In conclusion, by deducting the current analysis, it seems unlikely that the City's mobile based fault reporting systems adequately addresses the need for a universally accessible reporting system. Due to socially stratified patterns of access to ICT, it seems that the introduction of e-governance into the water and sanitation sector is likely amplifying the marginalisation of certain

disadvantaged groups, particularly those with mobility challenges, whose needs and capabilities have long been ignored in the design of public infrastructure. Considering that the introduction of ICT into a system will not change its outcomes, but will merely amplify whatever intents and capacities are already built into it, and that ICT percolates into a society from the top down along socioeconomic strata, it makes little sense to use electronic fault reporting to help the poor overcome the political intents of the apartheid era that restricted their access to water and sanitation services.

9.2.0 Recommendations

Regardless of water and sanitation users' technological capacity, systemic change will depend on the City designing fault reporting systems around the limitations and realities of the environments where they will be deployed. The SJC's (2014) claim that it is difficult to report the location of faults, because informal settlements lack a system of street addresses, shows that barriers to fault reporting go beyond the technological capacity of users. While this study identifies barriers to sending data, there is still a need to identify barriers to the absorption of data by the municipality. Also, as this study points out, access to the tools needed to participate in user generated fault reporting can be highly unequal. Identifying how to set up and run remote senor networks to automatically generate fault reports would complement the findings presented in this study, by building an understanding of how this emerging technology interacts with digital divides and ICT enabled amplification.

Furthermore, verifying the accuracy of the collected data fell beyond the scope of this study. Therefore, it would be worthwhile in the future to examine whether some of the results, such as the correlation between disability and frequency of toilet cleaning, are quantifiably reflected in reality, or if the results merely reflect a perception that facilities are cleaned less frequently due to the physical and emotional challenges presented by unhygienic toilets. It would also be beneficial for policy makers if future research focused on understanding why these socio-cultural factors impact access to facilities and technology. For instance,

assuming that people with disabilities are actually using toilets that are cleaned less frequently, it would be helpful to know what factors are causing this situation.

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x. Appendix

x.i. Survey Questionnaire

Non-Sensitive Sociocultural Questions

How many dependents do you have?
Have illness or injury prevented you from doing household chores in the past year? ☐Yes ☐No
What is your sex? ☐Male ☐Female
How would you describe your overall health?
☐Very good ☐Good ☐OK ☐Not so good ☐Bad ☐Very Bad

How long have you lived in Imizamo Yethu?
Where were you born?
What is your age?

Do you have any disability, or experience difficulty walking or completing physically demanding tasks? ☐Yes ☐No ☐Sometimes

What is the highest level of schooling you completed?
☐No schooling ☐Grade School ☐High School ☐Tertiary

Are you currently employed? ☐Yes ☐No
Do you receive a government grant? ☐Yes ☐No
Do you belong to any religious or community organisations? ☐Yes ☐No

Sensitive Sociocultural Questions (Complete Using ICVI)

What, if any, groups of people pose a threat to the morals or values of the community?
What, if any, groups of people threaten economic growth or job prospects in Imizamo Yethu?
What, if any, groups of people in Imizamo Yethu make you feel unsafe?

Water & Sanitation Questions

How far do you travel for water?
How far do you travel to use a toilet?
About how often do you wait more than 15 minutes to use water or sanitation facilities?
☐Every day ☐At least once a week ☐At least once a month ☐Every few months ☐Almost Never

Have you ever been assaulted, verbally or physically, while collecting water or going to the toilet?
☐Yes ☐No

How would you describe the quality of the toilet facilities you normally use?
☐Very good ☐Good ☐OK ☐Not so good ☐Bad ☐Very Bad

How would you describe the quality of the water?
☐Very good ☐Good ☐OK ☐Not so good ☐Bad ☐Very Bad

How often does your usual water get turned off?
☐Once a week ☐Once a month ☐Once every2- 3 moths ☐Once every 4-6 months ☐Almost never

How often does your usual toilet get cleaned?
☐Once a week ☐Once a month ☐Once every2- 3 moths ☐Once every 4-6 months ☐Almost never

ICT Questions

Have you used a mobile phone for any reason during the past week? ☐Yes ☐No
Do you own your own mobile phone? ☐Yes ☐No
Which of the following do you use your mobile phone for?
☐SMS ☐Calls ☐Sharing photos or video ☐Mobile Banking ☐Facebook
☐Mxit ☐Missed calls ☐Internet ☐Music ☐Games ☐Whatsapp ☐Email

Which of the features does your phone have?
☐Camera ☐Touchscreen ☐Radio ☐Internet ☐Voice Recorder

x.ii. Ethics Approval

EBE Faculty: Assessment of Ethics in Research Projects (Rev2)

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791).
NB: A copy of this signed form must be included with the thesis/dissertation/report when it is submitted for examination

This form must only be completed once the most recent revision EBE EIR Handbook has been read.

Name of Principal Researcher/Student: Wesley C. Hill Department: Civil Engineering

Preferred email address of the applicant: wesley.clifton.hill@gmail.com

If a Student: Degree: Mphil Supervisor: Ulrike Rivett

If a Research Contract indicate source of funding/sponsorship:

Research Project Title:
Identifying sociocultural indicators to the adoptability of ICT4D in the Water Sector: Case of Imizamo Yethu Township in Cape Town, South Africa

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	NO
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate. Ensure that you refer to the EIR Handbook to assist you in completing the documentation requirements for this form.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:		16-4-14
This application is approved by:		
Supervisor (if applicable):		16-4-14

Signed by candidate